

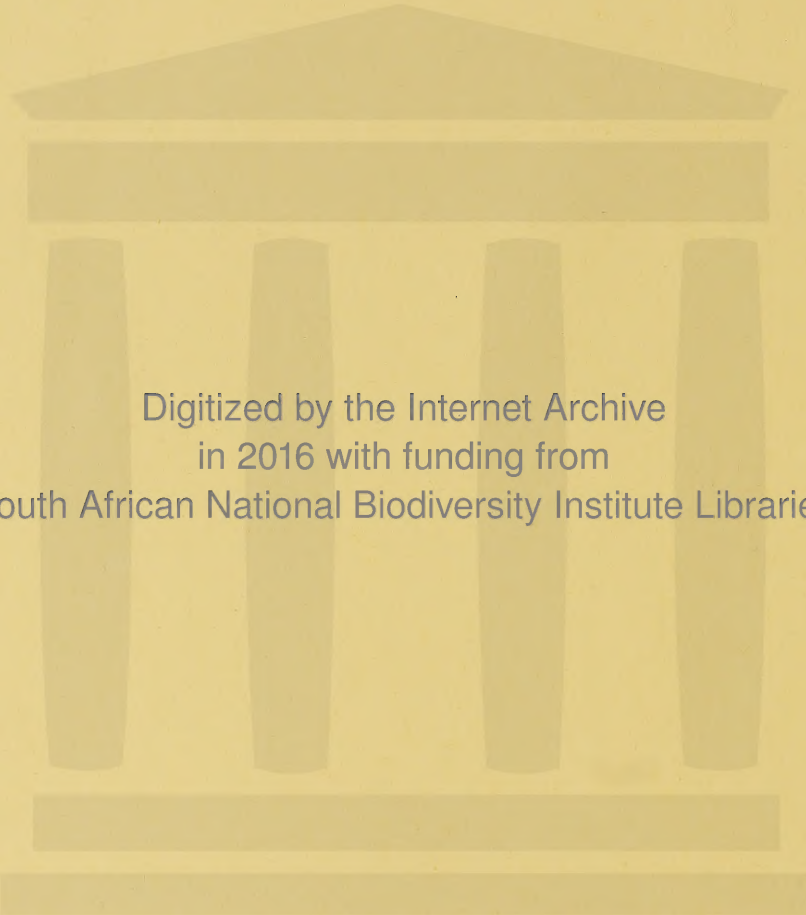
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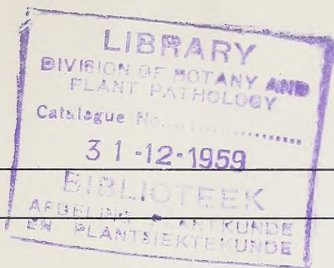
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CONTENTS.

	PAGE
ALOE SUCCOTRINA LAM. A HISTORY OF THE PLANT AND ITS NAME (with Plates I—IV), by G. W. Reynolds ..	1
THE IDENTITY OF ALOE KNIPHOFIODES BAK. (with Plates V—VI), by G. W. Reynolds ..	9
OXALIS LABURNIFOLIA JACQ. AND ITS STATUS AS A SPECIES, WITH A DESCRIPTION OF A NEW VARIETY, AND (II) NOTES ON THE AERIAL BULBILS IN O. LABURNIFOLIA, by Captain (S.) T. M. Salter, R.N. (Ret.) ..	13
THREE CLOSELY RELATED ACACIAS OF SOUTHERN AFRICA, by Rev. J. Gerstner, O.S.B., Ph.D. ..	19
PLANTAE NOVAE AFRICANAE, Series XXVIII, by Miss W. F. Barker, B.Sc., Miss G. J. Lewis, B.A., Mrs. M. R. Levyns, M.A., D.Sc., and the late C. E. Moss, M.A., D.Sc. ..	29
SOME NEW SPECIES AND VARIETIES IN THE GENUS HAWORTHIA, VI (with Plates VII—VIII), by G. G. Smith ..	41
VIEWS ON THE NAMING OF HAWORTHIAS (with Plate IX), by G. G. Smith ..	55
THE PARASITISM OF ALECTRA VOGELII BENTH. WITH SPECIAL REFERENCE TO THE GERMINATION OF ITS SEEDS, by P. J. Botha, M.Sc., Ph.D. ..	63
SOME CHANGES IN NOMENCLATURE, Series V, by Miss F. M. Leighton, B.Sc., Mrs. M. R. Levyns, M.A., D.Sc. and Miss G. J. Lewis, B.A. ..	81
A FIRST REPORT ON MYCORRHIZA ASSOCIATED WITH SOME TRANSVAAL PLANTS (with Plate X), by C. Cohen, M.Sc. ..	91
CHROMOSOMES IN A TRIPLOID GASTERIA (with Plate XI), by Dr. H. P. Riley, M.A., Ph.D. ..	97
THE FIRST FLOWERING OF WELWITSCHIA MIRABILIS HOOK. F. RAISED FROM SEEDS (with Plate XII), by H. Herre ..	105
THE CHROMOSOME NUMBER AND KARYOTYPE OF SENECIO ISATIDEUS DC. (with Plates XIII—XIV), by Miss E. P. Goldsmith, B.Sc. and Dr. S. Krupko, Ph.D. ..	107
OBSERVATIONS ON SOME WATER FUNGI COLLECTED IN AND AROUND JOHANNESBURG (with Plates XV—XVII), by Miss E. P. Goldsmith, B.Sc. ..	135
THE DEVELOPMENT OF THE OVULE AND THE SEED IN THE HYPOXIDEAE. PART I: IANTHE SALISB., by Miss M. P. de Vos ..	159
FURTHER NOTES ON SOUTH AFRICAN SAPOTACEAE, by Rev. J. Gerstner, O.S.B., Ph.D. ..	171
REVIEWS:	
W. J. TALBOT: Swartland and Sandveld (R. S. Adamson) ..	127
F. VERDOORN: Plants and Plant Science in Latin America (R. H. Compton) ..	128
E. D. MERRILL: Merrilliana, a Selection from the General Writings of, (R. H. Compton) ..	129
A. ARBER: Goethe's Botany (R. H. Compton) ..	129
C. S. RAFINESQUE: A Life of Travels (R. H. Compton) ..	130
H. A. JACK: Biological Field Stations of the World (R. H. Compton) ..	130
D. WYMAN: The Arboretums and Botanic Gardens of North America (R. H. Compton) ..	130
W. L. HOWARD: Luther Burbank, a Victim of Hero Worship (R. H. Compton) ..	131
K. S. CHESTER: The Nature and Prevention of the Cereal Rusts (J. E. van der Plank) ..	131
J. B. HUTCHINSON, R. B. SILOW and S. G. STEPHENS: The Evolution of Gossypium and the Differentiation of the Cultivated Cottons (H. B. Gilliland) ..	132
A. M. BOTTOMLEY: Gasteromycetes of South Africa (A. A. Pearson) ..	175
INDEX TO PLANT NAMES ..	177

JOURNAL
OF
SOUTH AFRICAN BOTANY
VOLUME XIV.

ALOE SUCCOTRINA LAM.

A HISTORY OF THE PLANT AND ITS NAME.

(With Plates I—IV.)

By G. W. REYNOLDS.

Of all the many and diverse epithets employed in the genus *Aloe*, none has such a historically interesting, albeit confused background, as *A. succotrina* Lam.

It is said that Aloes (the drug) was known to the Greeks as a product of the Island of Socotra as early as the fourth century before the Christian era (*Bot. Mag.* t. 6596 (1881)), while de Candolle *Plant. grass.* II 85 (1799) states that *Aloe Soccotrina* was discovered on that Island in 1508.

A very early reference to the use of the name *A. succotrina* will be found in The Great Herbal, first published in London by Thos. Gerard in 1597, amended by Thos. Johnson in 1633.

Under "of the Historie of Plants" Chap. 141, pp. 508—509, it is recorded that :

"The juice of this herbe *Aloe* (whereof is made that excellent and most familiar purger, called *Aloe Succotrina*) the best is that which is cleare and shining. This *Aloes* taken in a small quantitie after supper in a stewed prune . . . is a most souveraigne medicine to comfort the stomache. . . . This plant groweth very plentifully in India, in Arabia, Coelofuria and Aegipt from whence the juyce put into skins is brought into Europe."

The Island of Socotra is not mentioned as a locality of origin, but an *Aloe* plant is figured under the name "*Aloe vulgaris, sive Sempervivum marinum, Common Aloe, or Sea-Housleeke*". This figure is an exact reproduction of the *Aloe* figured in Dodonaeus *Stirpium Historiae* p. 355

(1583), which figure has been identified by Dr. E. D. Merrill, Administrator of Botanical Collections of Harvard University, as representing *A. vera* Linn.

At that time, and subsequently, the name *A. succotrina* was applied to the species now known as *A. vera*, and had no connection with the Island of Socotra, or with the Cape plant.

Another early record of the use of the epithet *succotrina* is to be found in O. Dapper's *Afrika: Naukeurige Beschrijvinge der Afrikaensche Gewesten* published in Amsterdam in 1688, with a further edition in 1676. In the 1668 edition, under "Het Eilant van Sokotora," a paragraph appears on p. 686 dealing with *A. succotrina*. The original Dutch is reproduced herein (Fig. 1), a translation of a portion of it being:

"The one thing which distinguishes this Island is the vegetation which produces the *Sokotoriner Aloes* which grow here in great quantities and better than anywhere else, and indeed the plant bears the name of the Island, although some do not spell it *Sokotorina* but *Succotrina*, as if they wanted to say *Succocitrina* because this Aloe, ground in a mortar is of a yellowish colour."

De zee, onder het eilant, verschaft
 hen veel grote visschen. Maer 't geen
 dit eilant boven mate vermaert maakt,
 is het gewas, daer de *Sokotoriner Aloë*
 van komt, die hier in grote meenigh-
 te, en nergens zo goet als op dit eilant
 valt; gelijcke daer ook den naem van
 voert; hoeweelenigen niet *Sokotori-*
na, maer *Succotrina* spelden, als of
 men *Succocitrina* wilde zeggen, om
 dat deze Aloë, in de vijfel gestoten,
 citroen geel van kleur is. Dit eilant
 heeft ook zijne vermaertheit beko-
 men, door den groten overvloed van
 draken-bloet, die als een Gom uit ze-
 zekere bomen, by d' Indianen *Ber* ge-
 noemt, komt druipen, nadat zy des
 voorgaenden jaers op een gezetren
 tijdt met een yzer in den schors des
 stams gequest zijn. d' Oever der
 zee werpt ook Ambre-grijs op.

FIG. 1. Reproduction of the paragraph on *Aloe Sokotorina* from the Island of Socotra, from p. 686 of Dapper's *Afrika*, Amsterdam (1668).

This appears to be the earliest record of the name *A. succotrina* being used for an Aloe found on the Island of Socotra. Dapper's reference to

"*Succocitrina*—yellowish in colour," is highly interesting, since it suggests that it could have been the yellowish colour of the dried sap which had a bearing on the choice of the name.

John Ogilby, in his *Africa*, London, p. 623 (1670)—which appears to be mostly an English translation of Dapper's work—also has a reference, under "The Island of Socotra", reading:

"But that which above all makes the Island famous is the plant from which the *Aloes Sicotrina* cometh . . ."

The Aloe found in abundance on the Island of Socotra to-day is *A. Perryi* Bak., figured in *Bot. Mag. t.* 6596 (1881). *A. Perryi* is, however, a species markedly distinct from both *A. vera*, and the Cape species known as *A. succotrina*.

Muntingius *Aloidarium* fol. 21 (1680) has a queer figure of *Aloe vera minor* which is cited as a synonym under *A. succotrina* by Haworth in *Trans. Linn. Soc.* VII, p. 20 (1804), while *Bot. Mag. t.* 1474 (1812) cites it under *A. succotrina* β *purpurascens*. The first published figure of *A. succotrina* is Plukenet *Phytographia*, vol. 2, tab. 240, fig. 4, London (1691), where, in the appendix to Part 3, it is figured under the name *Aloe americana ananafoliis florib., sauve rubentibus*. (Plate I, Fig. 1). The name suggests a plant of new world origin, but the figure clearly points to *A. succotrina* of the Cape, especially in the length of the pedicels.

Lamarck in his *Encyclopédie*, p. 85 (1783) cites this as a synonym for his *A. succotrina*, so does D.C. *Plant. grass.* 85 (1799), and Haworth in *Trans. Linn. Soc.* VII, p. 20 (1804), while *Bot. Mag., t.* 1474 cites it under *A. succotrina* β *purpurascens*.

The second figure is *Aloe succotrina angustifolia spinosa, flore purpureo* in Johan Commelin *Hort. Amst.* I, 91-92, t. 48 (1697). (Plate I, Fig. 2.) Commelin records that he obtained a young plant from Simon van Beaumont, Secretary to the States-General of Holland and West Friesland, and that it had been sent from the East Indies—by whom is not recorded. It must be remembered that in those early days the East Indies was a broad term which frequently included the Cape. Since Commelin's plant could not have come from the Dutch East Indies, and since the Island of Socotra is not mentioned, it must have been collected at the Cape. It flowered in Amsterdam in 1689, and 1690, in the month of February, and was the first South African species of Aloe to be grown in Europe. Commelin's final paragraph reads (from the Dutch):

"When the leaves are cut through, they give a yellow bitter sap which is better and more pleasant to the smell than that of the usual and true Aloe, whose sap is unpleasant and stinks, but the smell of this one conforms with that of the true *Aloe Succotrina*."

This indicates that Commelin recognised his Cape Aloe as differing from "the usual and true Aloe"—which presumably was *A. vera*.

Simon van Beaumont's plants were sold at Leiden on Tuesday, 27th August, 1726, and *A. succotrina* was among those listed for sale in the *Catalogus Horti Beaumontiani*. It is surprising that *A. succotrina* was not among the species of Aloe growing in the Dutch East India Company's Garden at the Cape in 1695, while Oldenland was Superintendent there.

Linnaeus in *Spec. plant.* 320 (1753) cites both Plukenet (*l.c.*) and Commelin (*l.c.*) as synonyms for his *A. perfoliata* var. ξ which later became *A. succotrina* Lam.

The *A. vera* of Miller in *Gard. Dict.* ed. 8 No. 15 (1768) is not the *A. vera* of Linnaeus. Miller states that his plant is the "true Succotrine Aloe", but it is not, it is the Cape species *A. succotrina* Lam.

The first to employ a binomial was Garsault in *Description des Plantes et Animaux*, etc., i. p. 73 (1767), in which he described *A. soccotrina* from "l'Isle de Saccotora". According to the Preface, p. iii, Garsault's figure, t. 102, was published separately in 1764. This figure is reproduced herein (Plate II, Fig. 1).

Although Garsault's work was post-Linnean in date, his nomenclature is pre-Linnean in character, many of his names being uninomial and others polynomial. According to International Rules, Art. 68 (4), specific epithets are illegitimate and must be rejected "when they are published in works in which the Linnean system of binary nomenclature for species was not consistently employed." Such binary names as Garsault did use, must, therefore, be rejected—and this includes his *A. soccotrina*.

The first to comply with the Rules was Lamarck, and thus, *A. succotrina* Lam. in *Encyclopédie Méthodique* I, p. 85 (1784) is upheld, both as regards the author and the spelling of the epithet. There is no figure, but Lamarck states: "This plant grows in the Indies and particularly on Soccotera Island. It is the best, the most beautiful, and the purest of the three kinds of Aloes available in the shops. . . . It is brought in leather bags from l'Isle de Soccotera." Lamarck's description, however, fits the Cape species, and not *A. Perryi* of Socotra.

A. succotrina is not mentioned in Hill's *Hortus Kewensis* (1769), but William Aiton in his *Hort. Kew.* I, p. 466 (1789) lists *A. perfoliata succotrina*. Aiton also lists a new name for the first time, namely, *A. perfoliata* var. *purpurascens*, but he gives no locality of origin for either.

The *A. sinuata* of Thunberg in *Prod. I.*, 61 (1794), *Diss. Aloe I.* (1785) and II., p. 182 (1800), also *Flora capens.* ed. Schult., p. 311 (1823) is *A. succotrina* Lam.

An excellent figure, both in artistry and detail, is that of the incomparable Redouté in D.C. *Plant. grass.* II, p. 85 (1799). (Plate II, Fig. 2.)

De Candolle states that his *A. Succotrina* originally came from the Cape of Good Hope and Barbados; and that the name was given to it because it is collected on "l'île de Succotora ou Zocotora." Notwithstanding this, a study of the figure establishes without doubt that the plant is the *A. succotrina* of the Cape, and not *A. vera* of Barbados or *A. Perryi* of Socotra.

Some of the early botanical travellers did not help matters but added to the confusion by incorrect references to *A. succotrina*. As an example, Masson in *Phil. Trans. Roy. Soc. Lond.*, vol. LXVI, p. 287 (1776) when on his second journey (with Thunberg) and when he was in the Riversdale District on November 12th, 1773, writes "On the declivities of these low hills grows the *aloe Socotorina* in large clumps . . . the peasants make great quantities of the gum aloes from the sap of the leaves which they sell at the Cape at from two to six pence per pound." *A. succotrina* has never been known in the Riversdale district, and Masson clearly confused *A. ferox* Mill.

Thunberg also has an incorrect reference to *A. succotrina*, for in his *Travels*, vol. I, p. 213 (1794), when on his return from "Caffraria," he refers to seeing hedges of the *Aloe succotrina* after leaving "Gert Clute's farm at Slange rivier". This is a locality some distance east of Swellendam and one where *A. succotrina* has never been known to occur wild.

Bot. Mag. t. 472 (1800) figures *A. perfoliata* var. *succotrina*, the Succotrine Aloe, while on t. 1474 (1812) *A. soccotrina* β *purpurascens*—"The Largest Succotrine Aloe,"—is figured. *Bot. Mag.* correctly regarded both as belonging to one species, and under the latter name sinks most of the earlier names as synonyms, including *A. purpurascens* Haw., *A. succotrina* Lam., *Comm. Hort. Amst.* I, t. 48 (1697), *Pluk. Phytog.*, t. 240 (1691). If subsequent workers had followed *Bot. Mag.* and upheld only one species, the position would have been clarified, but they did not.

Haworth in *Trans. Linn. Soc.* VII, p. 19 (1804) upholds *A. succotrina*, and he raises Aiton's *A. perfoliata purpurascens* to distinct specific rank, i.e. *A. purpurascens* (Ait.) Haw.; but he gives no locality of origin for either.

In the same work Haworth introduces a new name which must be considered, namely, *A. ramosa* Haw. in *Trans. Linn. Soc.* VII, p. 26 (1804), which both Baker and Berger cite as synonym under *A. purpurascens*. This is incorrect. Haworth founded his *A. ramosa* on *Aloe spinosa arborescens ramosa*, Pluk. *Phytog.*, t. 129, fig. 4 (1691), and on *Aloe capensis arborescens ramosa*, Pet. *Gaz.*, Cat. No. 264, t. 87, fig. 9 (1764). (Note: The cited cat. No. 264 is wrong; the correct number is 465.) A study of these figures is interesting. Plukenet's figure 4 on plate 129 is very clearly copied from the Claudius drawing of *A. dichotoma* on fol. 799 of the plants figured and included in Simon van der Stel's Journal of his Expedition to Namaqualand in 1685-86. (See Ed. Waterhouse, 1932 and *Journ. S.A. Bot.* XIII pl. VI, p. 28, 1947.)

Petiver's *Gazophylacii Naturae et Artis*, tab. 87, fig. 9, London (1711), repeated in the 1764 edition which has the cat. no. added, is also *A. dichotoma*, since it is an exact copy of Plukenet's figure but reversed. *A. ramosa* Haw. is, therefore, a synonym of *A. dichotoma* and not of *A. purpurascens*.

In *Hort. Kew* II, p. 292 (1811), Aiton also upholds both as species, and records "The Soccotrine Aloe, *A. soccotrina*, from the Cape of Good Hope and Barbadoes". He also upholds *A. purpurascens*, but for the first time the "Purple Aloe" is recorded as being native to the Cape of Good Hope. Since no precise locality is indicated, there is no knowing whether *A. purpurascens* hailed from the Peninsula, or from the mainland along the coast near Kleinmond or Hermanus.

From that time onwards, both *A. succotrina* and *A. purpurascens* have been upheld as specifically distinct. Haw. *Synops.*, p. 75 (1812) lists both from the Cape, while R. & S. *Syst. veg.*, p. 692 (1829) cites the Cape for *A. purpurascens*, and (p. 701) the Barbados for *A. soccotrina*. Salm Dyck *Monogr.* (1842) figures both, and Kunth *Enum.* IV (1843) also lists both.

Baker in *Journ. Linn. Soc.*, pp. 173-174 (1881) lists both, and he records a collecting of *A. succotrina* by Harry Bolus near Uitenhage. This is wrong; the Uitenhage plant was *A. pluridens* Haw., as Marloth has pointed out.

Baker in *Flora capens.* VI, 321-322 (1896) lists *A. succotrina* and *A. purpurascens*, but of the latter he says, "Scarcely more than a variety of *A. succotrina*".

It was not until 1906, however, that a precise locality was recorded where *A. succotrina* grew wild at the Cape. In a paper entitled "Notes on *Aloe succotrina* Lam.," read June 28, 1905, and published in *Trans.*

S. Af. Phil. Soc. XVI, p. 213 (1906) Marloth records that the species occurred on slopes of Table Mountain, about 1,200 ft. above Newlands (i.e. Kirstenbosch) on an immense field of boulders. He also records a variety "among the rocks of the so-called Little Lions Head near Hout Bay," and continues, "It is probable that a plant growing on rocks near the mouth of the Kleyn River is this species, or its nearest ally, *A. purpurascens*".

So, at long last, a precise locality was given for the species which had been "lost" for over 200 years. *A. succotrina* also occurs in numbers on the Karbonkelberg (See Plate III), near Hout Bay, but this locality, as well as Kirstenbosch, was then so difficult of access that it is highly unlikely that the original plant was collected at either of these localities. Was it perhaps collected on the Glencairn hills on the old road to Simonstown? The precise locality, it seems, will never be known, but one thing is certain and that is, that *A. succotrina* occurs wild at the Cape, and at no other known locality in the world. The precise locality of *A. purpurascens* is also not known.

It must be remembered that Aloes vary in their different localities and under varied climatic conditions. Plants from Kirstenbosch and Karbonkelberg in the Peninsula, and from Kleinmond and Hermanus on the mainland, have been grown in Johannesburg (See Plate IV) and compared when they flowered. Allowing for natural and expected minor differences between individuals, they very clearly constitute forms of one species only. The writer is, therefore, of opinion that *A. purpurascens* is not specifically distinct, and should be reduced to synonymy under *A. succotrina*. Berger (*l.c.* 283) describes a var. *saxigena* with straighter leaves, and larger marginal teeth, but without flowers. This variety, it appears, could also well be dropped.

It is not necessary to describe the species again, but the following is the synonymy:—

A. succotrina Lam. *Encycl.*, p. 85 (1783); Persoon *Synops. pl.* I, p. 378 (1805); Salm Dyck *Cat. rais.*, p. 28 (1817); *Hort. Dyck.*, p. 15 (1834); Salm Dyck *Monogr.*, sect. 22, fig. 1 (1842); Baker *Journ. Linn. Soc.*, p. 173 (1881), in Th. Dyer *Flora capens.* VI, p. 321 (1896); Marloth in *Trans. S. Af. Phil. Soc.* XVI, p. 213 (1906); Engler et Drude *Veget. Erde.* IX, II, p. 338 (1908); Berger in Engler *Pflrch. Liliac.-Aloin.*, p. 282 (1908); *Gard. Chron.*, ser. III, lvi, suppl. t. 400 (1914).—*A. succotrina* var. *saxigena* Berger (*l.c.*), p. 283 (1908).—*A. succotrina* Garsault *Descript. Plant. Anim.*, i, p. 73, t. 102 (1767); D.C. *Plant. grass.*, p. 85 (1799); Haworth *Trans. Linn. Soc.* VII, p. 19 (1804); Ait. *Hort. Kew* II, 292 (1811); Haw. *Synops.*, p. 75 (1812).—*A. succotrina* R. & S. *Syst. veg.*, p. 701 (1829); Kunth. *Enum.* IV, p. 524 (1843).—*A. perfoliata*

var. ξ Linn. *Spec. pl.* I. p. 320 (1753).—*A. perfoliata* var. *succotrina* Ait. *Hort. Kew.* I, p. 466 (1789); Curtis *Bot. Mag.*, t. 472 (1800).—*A. sinuata* Thunberg, *Prod.* I. p. 61 (1794), *Diss.* I (1785), II (1800), *Flora capens.* ed. Schult., p. 311 (1823).—*A. vera* Mill. *Gard. Dict.*, ed. 8, No. 15 (1768), non Linn.—*A. purpurascens* Haw. *Trans. Linn. Soc.* VII, p. 20 (1804); Ait. *Hort. Kew.* II, p. 292 (1811); Haw. *Synops.*, p. 75 (1812); R. & S. *Syst. veg.*, p. 692 (1829); *Hort. Dyck.*, p. 15 (1834); Salm Dyck *Monogr.*, sect. 22, fig. 2 (1842); Kunth. *Enum.* p. 524 (1843); Bak. *Journ. Linn. Soc.*, p. 174 (1881), Th. Dyer *Flora capens.* VI, p. 322 (1896); Berger in Engler *Pflrch. Liliac.-Aloin.*, p. 284 (1908).—*A. perfoliata* var. *purpurascens* Ait. *Hort. Kew.* I, p. 466 (1789).—*A. soccotrina* β *purpurascens* Ker-Gawl. in *Bot. Mag.*, t. 1474 (1812).

Pre-Linnean Nomenclature: *Aloe succotrina angustifolia spinosa, flore purpureo*.—Comm. *Hort. Amst.* I, 91-92, t. 48 (1697); Tillius *Cat. pl. Hort. Pis.*, p. 7 (1723); Linn. *Hort. Cliff.*, p. 131 (1737); Breyn. *fil. Prod.* II, p. 41 (1739).—*Aloe vera minor* Munt. *Aloid.*, fol. 21 (1680); Boerh. *Index* 2 No. 3 p. 129 (1727).—*Aloe Indiae Orientalis serrata sive succotrina vera floribus phoeniceis*, Hort. Beaum., p. 5 (1690).—*Aloe Americana ananafoliis florib., sauve rubentibus* Pluk. *Phytogr.* 2., t. 240, fig. 4 (1691).—*Aloe serrata sive succotrina angustifolia flore purpureo*, Cat. Hort. Beaum., No. 81, p. 7 (1726).

I desire to express my gratitude to Dr. E. D. Merrill, Administrator of Botanical Collections of Harvard University, for his identification of the *Aloe* figure in Dodonaeus *Stirpium Historiae*, p. 355 (1583); to Sir Edward Salisbury, Director of the Royal Botanic Gardens, Kew, for a transcription of Garsault's account in *Descr. Pl. Anim.*, p. 73 (1767) and for a photograph of his t. 102; to Dr. T. A. Sprague of Kew for a considered opinion on the nomenclature used by Garsault, and to Professor R. H. Compton, Director of the National Botanic Gardens, Kirstenbosch, for plants, photographs and data.



FIG. 1.



FIG. 2.

PLATE I.

A. succotrina Lam.

FIG. 1. The first figure published—from Plukenet *Phytographia*, vol. 2, t. 240, fig. 4, London (1691).

FIG. 2. The second figure—from Commelin : *Hort. Amst.* I, 91-92, t. 48, Amsterdam (1697).

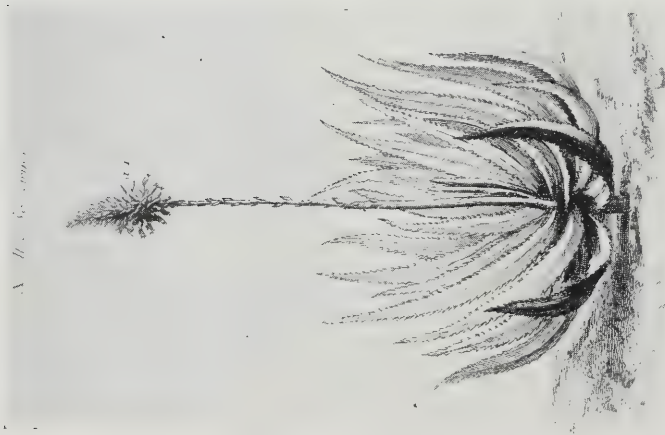


FIG. 1.



FIG. 2.

PLATE II.
A. succotrina Lam.

FIG. 1. *Aloe Succotrina* from Garsault *Descript. Plant. Anim.*, i., p. 73 (1767), t. 102, being published in 1764.

FIG. 2. Redouté's excellent figure of *A. succotrina* in D.C. *Plant. grass.* II, p. 85 (1799).



PLATE III

A. succotrina Lam.

Plants in natural habitat, on the Karbonkelberg, near Hout Bay, Cape Peninsula.
Fl. Aug., 1945.

Photos : Prof. R. H. Compton.



FIG. 1.



FIG. 2.



FIG. 3.

PLATE IV.
A. succotrina Lam.

- FIG. 1. A plant—from the Karbonkelberg—which flowered in Johannesburg in June, 1940.
FIG. 2. Raceme approx. 1/5.
FIG. 3. Flowers 1/1.

THE IDENTITY OF *ALOE KNIPHOFIOIDES* BAK.

(With Plates V and VI.)

By G. W. REYNOLDS.

The identity of *A. kniphofioides* Bak., which has remained in doubt since Tyson first collected this species in 1885, can now be established.

The first publication by Baker in Hook. *Icon. pl.*, t. 1939 (1890) is short, incomplete, and rather vague. It reads : "*Acaulis, foliis linearibus rigidulis ascendentibus margine serrulatis, floribus in racemum laxum simplicem elongatum dispositis, bracteis ovatis acuminatis, pedicellis ascendentibus bracteis subaequilongis, perianthio pallide rubello tubo cylindrico, segmentis lineari-oblongis tubo triplo brevioribus, genitalibus inclusis.*

"Hab. Pondoland, in damp, grassy places on Mount Enkansweni, near the high road between the river Umtamvuna (mis-spelt Umtamerina) and Emagusheni, alt. 4,000 ft., Dec., 1885, Tyson (2829).

"*Folia* pedalia vel sesquipedalia, $1\frac{1}{2}$ —2 lin. lata. *Racemus* pedalis. *Perianthium* 15—18 lin. longum." (Plate 1939 includes one linear leaf, and a laxly flowered raceme.)

In the second publication, Baker, in Th. Dyer *Fl. capens.* VI, 305 (1896), adds little to his original account, while Berger in Engler *Pflrch. Liliac-Aloin.* 170 (1908) merely takes over Baker's account.

Up to this point, descriptions were founded on Tyson 2829, and not on a whole plant.

(1) In Albany Museum Herb. there is a sheet of Tyson 2829, marked Type Number, comprising two inflorescences and three leaves, with a note, "From 1 to 2 ft. high, in the grass, leaves all springing from base. A very pretty species with its crimson spikes." There is also a water colour of a raceme and a leaf, marked : "Mt. Enkansweni. To be found between that locality and W.M.S. Emfundisweni, East Pondoland. Dec., 1886. W. Tyson."

(2) In the South African Museum, Cape Town, there are three sheets from Tyson's Herbarium of his 2829 ; one labelled TYPE comprises three inflorescences, and five leaves, the locality cited being, "Grassy places, Mount Enkansweni, between the Umtamvuna River and Fort William". A photograph of this sheet is reproduced herein. (Plate V.)

(3) In Nat. Herb., Pretoria, there is also a sheet of Tyson 2829, very similar to the two above mentioned. All the sheets comprise leaves and inflorescence only—*none being of a whole plant*.

The type locality is, therefore, slopes of Mt. Enkansweni, between the Umtamvuna River and Emagusheni, Fort William, or the W.M.S. Emfundisweni. Mt. Enkansweni lies about five miles north-east of Emagusheni, which is a trading station on the road from Kokstad to Flagstaff. From the top of Enkansweni traces of the old road can still be seen. This was the only road from Pondoland to Natal in 1885, and much gun-running was carried on over it. In late January, 1940, the writer especially visited that locality in quest of *A. kniphofioides*, but though he searched far and wide his efforts were fruitless, probably due to flowers being over, since the species flowers in November to early December.

A clue to the solution of the puzzle was eventually provided by two sheets named *A. kniphofioides* in the Nat. Herb., Pretoria, namely Frank Brownlee 235, "On the banks of the Goxo River, Mt. Ayliff Dist., 3 Dec., 1920". The Goxo (Goxe or Coxo) River, a tributary of the Umtamvuna River, lies a few miles northwards of Mt. Enkansweni. Tyson's and Brownlee's localities are, therefore, comparatively adjacent.

Brownlee 235 comprises two *whole plants*, in which the linear leaves dilate considerably below ground level, becoming imbricate, and forming an ovoid bulb-like swelling below ground level.

The type specimen in Herb. Natal of *A. Marshallii* Wood et Evans, described in *Journ. Bot.*, p. 353 (1897), is J. Medley Wood 5192! Kelvin Grove (near Dundee, Natal), alt. 4-5,000 ped., 5/13/93. A note on the sheet reads, "Dr. Schönland, Oct., '04, thinks this is probably *A. kniphofioides* Bak. in *Icones Plant.* t. 1939, Sept., 1890—an earlier name."

Schönland was correct, the plants are very clearly conspecific; the earlier name *A. kniphofioides* must, therefore, be upheld, and *A. Marshallii* reduced to synonymy.

It is now evident that Tyson cut leaves and inflorescences *at ground level*, and by so doing missed the most distinguishing character of the species, namely, the leaves dilating and forming an ovoid bulb *below ground level*.

In the material of Tyson and Brownlee, the dried perianth is 33 mm. long, which suggests that living plants had slightly longer flowers. The species does not appear to have been collected between Pondoland and Dundee, Natal, but from personal observation it occurs in numbers near Utrecht, Natal; near Wakkerstroom, Piet Retief, Amsterdam, Barberton, White River and Rosehaugh, Transvaal; and almost throughout the

mountainous portions of Northern Swaziland. In these localities inflorescences reach a height of 40—55 cm., while flowers vary in length from 30 mm. in weak forms to 55 mm. in robust specimens, the average being 45—50 mm.

The following is the synonymy, together with description founded on the type and on plants observed in Natal, Swaziland, and the Eastern Transvaal :

Aloe kniphofioides Bak. in Hook. *Icon. plant.*, t. 1939 (Sept., 1890), in Th. Dyer *Fl. capens.* VI, 305 (1896); Berger in Engler *Pflrch. Liliac.-Aloin.*, 170 (1908).—*A. Marshallii* Wood et Evans in *Journ Bot.* XXXV, 353 (1897); Berger in Engler *Pflrch. Liliac.-Aloin.*, 171 (1908).
Note : Berger upheld both as species.

Plant acaulescent, solitary, with ovoid bulb-like swelling under ground, and fusiform roots. *Leaves* multifarious, about 20, narrowly linear, 20—30 cm. long, 6—7 mm. broad; upper surface flat to slightly canaliculate, lower surface convex; both surfaces green, without spots; margins entire or minutely dentate, the teeth white, retrospectively unicate, larger and more crowded low down, more distant and obsolescent upwards; below ground level the leaves imbricate, dilating to 25—30 mm. wide at base, about 5 mm. thick, and forming a distinct ovoid bulb-like swelling 6—8 cm. long, 5—6 cm. diam. *Inflorescence* simple, sometimes 2, up to 55 cm. tall, standing out above the leaf apices. *Peduncle* terete, 4—5 mm. diam., sterile bracteate from the middle upwards, the sterile bracts brownish, scarious, ovate-acuminate, about 15 mm. long, 7 mm. broad, 7—9 nerved. *Racemes* 10—15 flowered, about 10—15 cm. long, the buds more crowded, the flowers more laxly disposed, scarlet with greenish tips. *Bracts* narrowly ovate acuminate, up to 15 mm. long, thin, scarious, pale brownish, 7—9 nerved, a little longer than their pedicels. *Pedicels* lowest up to 15 mm. *Perianth* cylindrical, slightly curved, 30—50 mm. long, (45—50 mm. the average). *Outer segments* free for 6—8 mm., apices sub-acute, straight, obscurely nerved. *Inner segments* dorsally cohering to the outer for their greater length, broader than the outer, the free portion with a greenish keel, the apices almost rounded. *Filaments* flattened, the 3 inner narrower and lengthening in advance of the 3 outer. *Genitals* not or very shortly exerted. *Ovary* 6—7 mm. long, 2·5 mm. diam. (Plate VI.)

With its underground ovoid bulb, *A. kniphofioides* seems to be nearest allied to *A. bulbicaulis* Christian from the Northern Rhodesian-Belgian Congo border (see *Fl. Pl. S. Af.*, vol. XVI, Plate 630, 1936), but the latter is an entirely different plant with very different considerably larger leaves, a branched inflorescence, and very different flowers.

With its narrow linear leaves, *A. kniphofioides* is nearest allied to *A. chortolirioides* Berger, *A. Woolliana* Pole Evans and *A. dominella* Reynolds in the Section *Leptoaloe*, but differs from all known species (except *A. bulbicaulis*) with its underground ovoid bulb.



PLATE V.

A. kniphoides Bak.

Photograph of the type material (Tyson 2829), in the South African Museum, Cape Town.



FIG. 2.

PLATE VI.

A. kniphofiooides Bak.



FIG. 3.



FIG. 1.

- FIG. 1. Plant in natural habitat : near Piet Retief, Eastern Transvaal $\times 1/6$.
 FIG. 2. Two plants removed from the ground to show the underground ovoid bulb-like swelling $\times 1/5$.
 FIG. 3. Flowers natural size.

OXALIS LABURNIFOLIA JACQ. AND ITS STATUS AS A SPECIES, WITH A DESCRIPTION OF A NEW VARIETY AND (II) NOTES ON THE AERIAL BULBILS IN OXALIS LABURNIFOLIA JACQ.

By Captain (S) T. M. SALTER, R.N. (Ret.).

Oxalis laburnifolia Jacq. was described and figured (No. 42, tab. 28) in Jacquin's *Oxalis Monographia* (1794) from a long-styled plant grown in Vienna, from bulbs probably obtained by the collectors Boos and Scholl in 1786. Another form of it is also figured (No. 42, tab. 29) under the name *O. sanguinea* Jacq., the latter plant only differing in being medio-styled. Jacquin did not realise that the flowers of *Oxalis* were trimorphic, and the two are undoubtedly conspecific.* Until recent years the only other collecting of this species was that of Zeyher, about 120 years ago (No. 225, from between Olifant's River and Knackisberg).

In 1935 it was re-discovered by Dr. P. Le F. Nortier of Clanwilliam, who kindly directed me to the site on the Ouplaas Hills, about 3 miles north-west of Klaver in the Van Rhyn's Dorp Division, where a set of specimens, *Salter 5445*, identical with Zeyher's specimens, was collected and bulbs were planted at Kirstenbosch.

In *Zeyher 225* the oblong leaflets† were narrower than those figured by Jacquin and it was treated by Sonder as a variety (var. *angustata* Sond.), but, as in the case of some other species of *Oxalis*, the leaflets sometimes tend to become wider in cultivation. Bulbs grown from *Salter 5445* produced leaves very similar to those in Jacquin's figure and Sonder's variety cannot, therefore, be upheld. Turczaninow did not recognise Zeyher's specimens as *O. laburnifolia* and gave them the name *O. arthrophylla* Turcz., now a synonym.

There are, however, two other forms of this species, one with the typical rotund leaflets of *O. purpurea* L., the other somewhat variable but always with longer leaflets and intermediate with the typical *O. laburnifolia*. All three, however, are practically identical in all other respects, having the characteristic corolla tube and pellucidly-streaked leaflets of *O. purpurea* L., though the latter character is not very obvious

* In both Figures only bulbils are shown. The mature bulb is ovoid or oblong-ovoid, hard, dark brown, somewhat sticky, up to 6 cm. long.

† Outlines of the leaves in the different Forms of *O. laburnifolia* are shown in Fig. 1.

until the plant is dried and the streaks turn black. In all three forms the juvenile leaves are rotund.

In my revision of the South African *Oxalis*,* after some consideration, I placed all three forms as Forms E (i), E (ii) and E (iii) of *O. purpurea* L., principally because the common and more widely distributed form with rotund leaflets and with both primrose-yellow and white flowers, is not easy to distinguish from several of the other Forms of *O. purpurea* L. either in the flowering stage or after drying. Although I was aware that in cultivation both the rotund Form E (i) and the intermediate Form E (ii) produce masses of small aerial bulbils in the axils of the leaves, a character not observed in any of the other Forms of *O. purpurea*, the only surviving plant of Form E (iii), the typical *O. laburnifolia* (Salter 5445) *did not produce them*. The plant was sickly and on its last legs, which may account for its failure to do so.

Last year Dr. Nortier was good enough to collect for me a fresh set of bulbs of the typical *O. laburnifolia* from 24 miles north of Lambert's Bay, i.e. in the region of the previous collectings. This year these plants (Nat. Bot. Gar. 263/46) have also produced similar aerial bulbils.

All three Forms have the following characters in common, distinguishing them from *O. purpurea* L.—a red, somewhat flattened petiole with a perceptible channel along the upper side, a reddening, often intense, on the under face of the leaflets or more rarely confined to the veins, and the very important characters of the aerial bulbils and the action of the contractile root in the second year, as explained in Part II. I am, therefore, now of opinion that *O. laburnifolia* and its group should retain specific rank.

No evidence of hybridisation between the three Forms has been observed, and in the only case where two of them, E (i) and E (iii), were found in association, there were no intermediate plants.† The intermediate plant is rather local and each colony observed has been of one pure strain. Since the transition between the two forms with broader leaflets may not be absolutely definite, one variety *latifolia*, with Forms A and B, is proposed.

***Oxalis laburnifolia* Jacq. var. *latifolia* Salter, var. nov. (*O. purpurea* L., Forms E (i) and E (ii) Salter). *Foliola* quam typica latiora, infra saturate rubra, lineis parvis obscure pellucidis (quum siccis atris) punctata, raro brunneo-maculata: medianum rotundatum basin versus plus minusve**

* The Genus *Oxalis* in South Africa, a Taxonomic Revision (Salter), Kirstenbosch, 1944, p. 140.

† The set Zeyher 225 in the South African Museum consists of 9 specimens of the form with narrow leaflets and one with leaflets of the intermediate form (Form E (ii)). Owing to the mistakes in distribution or mounting of Zeyher's specimens, it is impossible to say whether this was collected at the same time as the others.

attenuatum, quam latum parum longius ad duplo longius : lateralialia minora, rotundata vel obovato-oblonga vel fere semiorbicularia. Corolla lacteo-lutea vel alba tubo luteo.

Leaflets broader than in the *type*, deep red beneath, dotted with short inconspicuous pellucid streaks, rarely brown-mottled, the medial rotund, more or less attenuate at the base, from little longer to twice as long as broad, the lateral smaller, rotund, obovate-rotund or almost semi-circular. Corolla primrose yellow, or white with a yellow tube.

Form **A.** (*O. purpurea* L., Form E (i) Salter). Medial leaflet little longer than broad. Corolla primrose yellow or white.

Yellow : Clanwilliam Div. ; Salter 676, 724, 728, 744, 2149, 2448, 2600, 3423, 8126 ; 12 miles north of Clanwilliam, Salter 5613 (*type* ex. Herb. Salter* at Kirstenbosch) : Picketberg Div. ; Salter 664, 5653, Pillans 6631. White : Clanwilliam Div. ; Salter 677, 6632.

There may be other specimens in Herbaria. It would probably be impossible to distinguish them from some of the other Forms of *O. purpurea* L., since they are now colourless and the aerial bulbils do not develop in the flowering stage. Moreover, the majority of the specimens cited above have not been definitely seen producing aerial bulbils.

Form **B.** (*O. purpurea* L., Form E (ii) Salter). Leaflets usually larger, the medial once and a half to twice as long as broad. Corolla primrose yellow.

Clanwilliam Div. ; $5\frac{1}{2}$ miles west of Graafwater, Salter 7245 (*type* ex. Herb. Salter at Kirstenbosch), and separate colonies in the vicinity, 7243, 7247.

Note :—In the typical form of *O. laburnifolia* the medial leaflet is 3—5 times as long as broad and the leaflets most commonly only red on the medial vein beneath. In all three forms the corollas and leaves soon become colourless after drying.

These notes illustrate to some extent the exceptional difficulties which confront the systematist in classifying the species in this genus without the fullest data from living plants and the impossibility of working from herbarium specimens alone.

II. NOTES ON THE AERIAL BULBILS OF *OXALIS LABURNIFOLIA* JACQ.

The life-cycle of the aerial bulbils produced in the axils of the leaves of *Oxalis* is at present very imperfectly known. Several species† produce them, mostly those of the acaulescent type. How far, if at all, their

* My personal collection of South African *Oxalis* has now been incorporated in the Herbarium at the National Botanic Gardens at Kirstenbosch.

† See "The Genus *Oxalis* in South Africa," p. 35.

development is subject to the age of the plant or possibly, in some species, influenced by lack of fertilisation of the flowers, is an elaborate problem.

These notes are confined to observation of the aerial bulbils in *O. laburnifolia* Jacq., var. *latifolia* Salter, Form B, growing in the National Botanic Gardens at Kirstenbosch (Salter 7243). In all forms of this species robust plants, at least, produce such bulbils in cultivation.

Unlike the species *O. Fergusoniae* Salter, where the aerial bulbils are well developed at flowering time, here they do not appear until the flowers are well over, i.e. in August. They form a hedgehog-like mass at the crown of the rhizome and they seem to mature rapidly and soon break away at a touch. Several hundreds of such bulbils may be produced by a healthy plant and in their natural habitat, in this case a region where baking sun and high winds are the rule, owing to their chaff-like nature, their mortality must be enormous, since, on falling from the parent plant, they are inactive until the following April or May. Though they are capable of developing into new plants while lying on the surface of the soil, it is probably that, as a rule, only those survive that are blown into crevices or washed into the soil by rain.

A number of these bulbils, after gathering in September, were placed on the surface of the soil in a glass dish and moistened from time to time. Eventually, in April, they began to send down a slender pale root from the base. Unfortunately mould set in and the experiment went no farther, but one of these bulbils, with a basal root about 6 mm. long, was dried in a capsule and was found later to have produced colourless stem and leaf growth, a characteristic of all *Oxalis* bulbs in the herbarium if they are not thoroughly soaked with poison.

Mr. F. W. Thorns, late curator at Kirstenbosch, had, at my request, "sowed" some of these bulbils in a tin in the open, half on the surface and half just covered with soil. Growth was more marked in the case of those covered, but it is not known how far those placed on the surface may have suffered from outside interference, such as birds, slugs, etc.

The next stage of observation was that of the minute plants growing from aerial bulbils around the parent plants in the nursery beds at Kirstenbosch. These were taken out late in August. They were found in the state shown in diagrammatic form in Fig. 1. A new bulb, 1—2 cm. long (*b*) is produced at a depth of 3—6 cm. on a short stalk (*s*) emerging from the base of a very slender (about 0.1 mm. in diam.) intercalary elongation (*e*) of the rhizome or short underground stem (*r*), the original aerial bulbil being exhausted, with its tunics (*t*) persisting loosely in their original position around the base of the rhizome where it commences its elongation downwards. Immediately below the new bulb (*b*) is a root, contractile and shrivelled in its upper part, 0.5—1 mm. in diam. (*cr*), but slender and

non-contractile below (*n*). The nature of this contractile root in its earlier stages still requires investigating.

Two-year-old plants examined in September and October show that the contractile action in the second year appears to be exactly similar. Here a new bulb, on a lateral stalk above the small shrivelled contractile

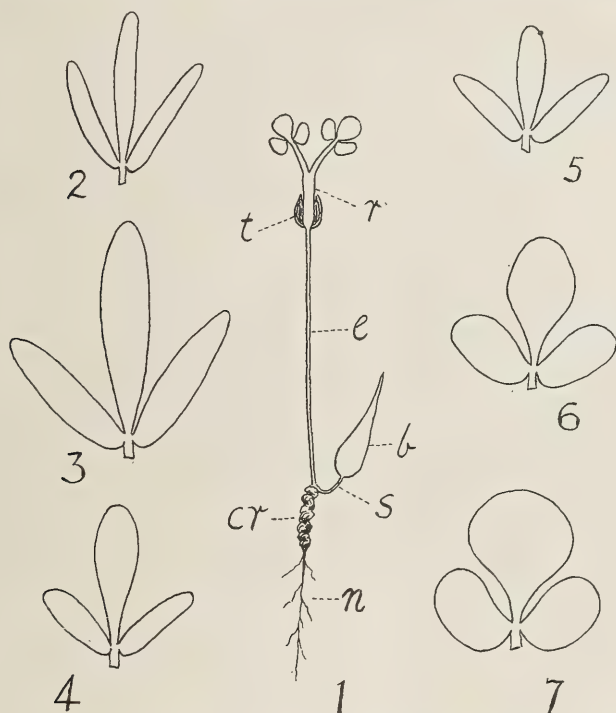


FIG. 1. 1. Diagram of young plant produced from an aerial bulbil of *Oxalis latifolia* Jacq., var. *latifolia* Salter, Form B; (*r*) rhizome; (*t*) tunics of aerial bulb; (*e*) intercalary elongation; (*b*) new bulb on stalk (*s*); (*cr*) contractile part of the root; (*n*) non-contractile part. Outlines of leaves of Forms of *O. latifolia* Jacq. (all half natural size). 2. Zeyher 225 (wild). 3. and 4. Salter 5445 (cult.). 5. Ditto (wild). 6. Var. *latifolia*, Form B. 7. Ditto, Form A. (Del. T. M. Salter.)

root, was found to have been drawn down to a depth of 11.5 cm., probably the final depth required, but such bulbs have not attained the size of those in fully grown plants.

Though it has not been followed through all its stages, the lowering

process seems to differ from that of the large slug-like contractile root in such species as e.g. *O. incarnata* L., *O. dentata* Jacq., and *O. purpurea* L. in its younger stages, where the new nutritive bulb scales are almost completely formed within the old bulb before being drawn out and are sessile on the summit of the contractile root.

In the case of the aerial bulbils it is presumed that the origin of the new bulb is a minute bud or bulbil produced in the base of the original bulbil, and, indeed, in one particularly large fresh bulbil, what appeared to be a very minute bud was found on dissection. Even if it began to grow *in situ* there would be no room for it, at its present size, in the aerial bulbil and it probably does not develop until after the contractile action is completed. The intercalary elongation is quite naked as it is in the case of *O. incarnata* and *O. dentata* and there is no trace of any free root-cortex forming a tube for its descent as is the case of the species in § Crassulae, e.g. *O. flava* L.

In "The Genus *Oxalis*" (p. 31) I referred to the new bulb in species of the § Crassulae* as "being formed laterally on the lower part of the inner core of a specialised root," being then unaware that it actually descends, while still minute, from the base of the original bulb by intercalary elongation of the stem through the loose cortical tube of the root, as noticed by Hildebrand†, nor that there is a further contractile action of the core below it, as since pointed out by Miss A. J. Davey‡.

ACKNOWLEDGEMENTS.

My thanks are due to Dr. P. Le F. Nortier for obtaining the bulbs, which enabled me to continue my investigation of *Oxalis laburnifolia* and to Dr. M. R. Levyns for her advice in the preparation of Part II of these Notes.

I would also like to take this opportunity of expressing my thanks to Mr. F. W. Thorns, the late Curator at Kirstenbosch, for the particular care that was exercised in preserving the *Oxalis* bulbs when the new terracing of the Nursery Garden was undertaken and they had to be transplanted, many of them from a great depth: also for the great interest that he took in their welfare in the Gardens.

* In any future taxonomic revision of the genus and, when the necessary data have been obtained, it would probably be better to include in sub-sections of § Crassulae all the species with this type of underground development, e.g. *O. suavis* R. Knuth, now in § Latifoliolatae and *O. tomentosa* L.f. and *O. palmifrons* Salter in § Multifoliolatae. There are, however, several species in which the action has not been investigated.

† Hildebrand, *Lebenverhältnisse der Oxalis-Arten* (1884) t. I.

‡ A. J. Davey, On the Seedling of *Oxalis hirta* L. *Annals of Botany* X (1946), pp. 250-1.

THREE CLOSELY RELATED ACACIAS OF SOUTHERN AFRICA.

By Rev. J. GERSTNER.

I. COMPARATIVE STUDY OF THE THREE SPECIES CONCERNED.

The thorny South African Acacias have been, for more than a century, a rather thorny problem for the taxonomist. In particular, *A. natalitia* and *A. hirtella*, i.e. the species nearly related to *A. karroo*, offer great difficulty in verification for the botanist who has only herbarium specimens for his guidance. The primitive Zulu, with his veld experience, who recognizes the tree from afar by its particular shape and habitat, and who is more interested in the timber and bark and in the ability of regeneration of the tree after veld fires, etc., has since ancient times a much clearer idea of these Acacias than we Europeans with our magnifying lenses. He distinguishes well between the three species known to him in hundreds of cases as "umuNga," i.e. *A. karroo* Hayne, "umSama," i.e. *A. natalitia* E. Mey, and "isiKhombe," i.e. *A. inconflagrabilis* Gerstner, a new species described at the end of this paper, which has hitherto been overlooked or confused with the first two.

These three species do not possess the usual stipules but instead of them straight, whitish, twin spines, which we have to consider as transformed stipules. These spines, in the case of *A. karroo* at least, are often inflated, confluent and infested by a certain species of black ant, *Cataulacus rugosus*, which lay their eggs in cavities which they make in the young soft thorns.

The flowers, which vary from 1—6 in number, are produced in fascicles or spurs in the axils of the present or later developed leaves. They are arranged in globose flower-heads of 10—12 mm. diameter and are of a bright yellow colour, like the yolk of an egg.

Different kinds of beetles (Lamellicornia) and other insects effect cross-pollination. This seems to be necessary, because isolated plants often bear no fruits. The seeds are distributed by ruminants eating the pods. Wild game animals, such as duikers, do not swallow the seeds, but cattle swallow them. They do not, however, digest the very hard seeds,

which are merely stimulated in the digestive tract. No wonder that all these species of *Acacia* frequently become a pest on cattle farms of the thorn- and lowveld.

The pods, seeds, flowers, leaves and spines of all these three species vary considerably, but are very much alike, inter se, and, therefore, of very little taxonomic value. Of more systematic value are the complete inflorescences, in their form and way of developing. All three species have the flowers arranged in axillary spurs, i.e. fascicles of 1—6 in the axils of the leaves. *A. karroo* and *A. natalitia* seem to produce apical and lateral inflorescences. But these apical inflorescences are false ones because the subtending leaves always develop later on. The inflorescences of *A. karroo* are also the densest (densiflorous); those of *A. inconflagrabilis* are laxiflorous and those of *A. natalitia* more or less intermediate between the others.

The leaflets (pinnulae), if fresh, provide us with the most characteristic features. Their apex in the case of *A. karroo* is round as a rule, and their form is shorter; in the case of the two others the apex is mostly acute and their form longer. *A. inconflagrabilis* has even a tendency to be slightly apiculate in its apex, especially in its young state. *A. karroo* can, therefore, even in dried Herbarium material, always be verified with the help of a good magnifying lens by the form of its pinnula, which is quite distinct from the two others. Cf. the middle figure. This rule, dealing with the form of the leaflets, cannot be used very strictly but only in an average way, as there are always plenty of exceptions in consequence of shade or varied nutrition. The greatest difficulty facing the taxonomist, who has only Herbarium material at his disposal, is the differentiation between the pinnulae of *A. natalitia* and *A. inconflagrabilis*. Although it is quite easy to distinguish the two by the surface of the pinnulae in the fresh state, it is much more difficult in dealing with dried material. In the fresh state, the pinnulae of *A. inconflagrabilis* are shiny and totally glabrous; those of *A. natalitia* dull, and in the young state, hairy. But *A. inconflagrabilis* turns dull in the plant press like *A. natalitia*, and produces, through its pores, hairlike excretions of gum, which give this totally glabrous species a hairy (hirtella?) appearance in the Herbarium.

In the veld, diagnosis will be assisted by observing that *A. karroo* is a medium-sized tree with a plum tree shape. *A. natalitia*, in pure form, is a slightly taller tree of pear tree shape; whereas *A. inconflagrabilis* is always a shrub of 6—12 ft., resisting the veld fires very well, as its name indicates, and regenerating, even more abundantly, after such catastrophes. The two other species usually succumb to heavy veld fires.

The bark of *A. karroo* is also very distinct, being shallowly fissured longitudinally and rather dark when old, if not black. The bark of the two others is rather smooth, sometimes more or less verrucose, and horizontally furrowed when old. The bark of *A. natalitia*, as stated by E. Meyer, more than a hundred years ago, is light, and that of *A. inconflagrabilis*, dark or black in age. Purely vegetative Herbarium specimens of these two, if already dried, are impossible to distinguish. The collector of *Acacia* specimens should always try to get flowering and fruiting specimens, accompanied by samples of the bark, and filled-in labels and tickets. The tickets should be fixed to every specimen with number and collector's name, written in lead pencil only, so that it cannot be spoilt in the poisoning solution. On the label, the colour of the catkins (which all turn yellow in the plant press) in the fresh state, the habitat or accompanying plants, the soil or geological stratum, the shape of the tree, the height, diameter, the native names (written, if possible, by a native) and the use they make of it, should all be recorded.

II. GEOGRAPHICAL DISTRIBUTION.

A. karroo is distributed throughout the whole Union and South-West Africa, from the Cape Peninsula to the tropical part of Southern Africa, and from the Atlantic to the Indian Ocean.

A. natalitia occurs on the coast, preferring sandy soils, and in the river bushes of the mist-belt area and lowveld. In the latter case, its habitat often overlaps that of *A. karroo*, and I have observed in these areas many cases of hybrids between *A. karroo* and *A. natalitia*. The bark in these cases is usually very dark, but smooth or horizontally furrowed. Inflorescences and pinnulae show intermediate forms as well. *A. karroo*, var. *transvaalensis* Burt Davy and *Acacia hirtella* E. Mey. may belong here. These hybrids are either single occurrences here and there, spontaneously coming up and disappearing again, or well established, local varieties as mentioned above.

A. inconflagrabilis seems, in my experience, only to be found in the midlands of Natal and Zululand in the transition area between mist-belt forests and savannah, e.g. in Nongoma Township, Melmoth, Imfule, etc. The stoloniferous variety of *A. natalitia*, mentioned by E. E. Galpin in his "Botanical Survey of the Springbok Flats," which I have not yet seen in its natural state, may belong to this species.

III. SYSTEMATICS.

1. *A. karroo* Hayne is the best known of these three species of *Acacia* and needs no additional notes besides the remarks already made, and the accompanying figure.

2. *A. natalitia* E. Mey.

For better guidance, I give herewith the original Latin description of E. Meyer, followed by an English translation and additional notes :

"*Acacia natalitia* E. Mey. aculeis geminis stipularibus rectis, erectis, foliis 4—7 jugis, glandulis inter juga omnia, pinnis 12—18 jugis, foliis linearibus, obtusis, glabris, opacis, capitulis pedunculatis axillaribus fasciculatis. Port Natal, Umgeni, 300 ft. Antecedente similis et fructu adhuc ignoto definitu difficilis. Attamen diversam puto cortice albente nec fusco, aculeis saepe brevissimis et vix ullis, numquam 9 lineas longis, rectis quidem, sed erectis, nec divergentibus, foliorum pinnis pinnulisque pluribus, foliis paulo minoribus praecipue angustioribus, apice obtusis quidem sed non rotundatis, opacis nec pallentibus, capitulisque duplo fere minoribus."

Translation into English :

"*Acacia natalitia* E. Mey. with straight, erect, twin thorns ; leaves having 4—7 pairs of pinnae, and between each pair, a gland ; pinnae having 12—18 pairs of pinnulae, which are linear, obtuse, glabrous, dull ; flower-heads pedunculate, capitate, arranged in axillary fascicles. Port Natal, Umgeni, 300 ft. It is similar to the previous species, but as the fruit is not yet known, it is difficult to define. I think it differs, however, in its whitish and not blackish bark, in its spines being often very short or nearly wanting, never 9 lines long, straight indeed, but erect and not divergent. The pinnae and pinnulae of the leaves are more numerous, the leaflets a little smaller and especially more narrow. The apex of the leaflets is, although obtuse, not rotundate ; dull, not pale, and the globose flower-heads only half the size."

When I compare these old descriptions of our *Acacias*, I remember the verses of the old Swiss botanist and poet Haller (after whom his friend Linnaeus named our genus *Halleria*) :

"Cucumber, Aloe, Canterbury bell—
To all the description fits full well."

(Translated.)

Unfortunately, the description of *A. natalitia*, as given by E. Meyer, is based on his two specimen numbers, one collected at Durban, and one at Umkomaas. They are only two incomplete, special cases, and do not

cover at all the whole ontogenesis of *A. natalitia* with all its modifications in different environments and rainfall periods and its variations produced by interbreeding with others species of Acacia like *A. karroo*.

In his remark, "It is similar to the previous one," he refers to *A. karroo*. The fruit of *A. natalitia*, unknown to Meyer, is known to us and is so much like the fruit of *A. karroo* that it offers no good features to be used as a basis for distinctive taxonomy. The same is the case with the size and number of the flowers, the number of the pinnae and pinnulae, and the form and size of the thorns.

More constant features are the different habitats, the shape of the tree, the colour and form of the bark, the inflorescence and its combination as a whole and the form and surface of the pinnulae. Of these important features only the colour of the bark and the different form of the pinnulae are mentioned in Meyer's original description, but are sufficient to identify *A. natalitia* as the distinct species known to us by the Zulu name "umSama". Meyer does not mention that the surface of the bark is smooth and only horizontally furrowed in age, in contrast with *A. karroo*, which has the bark longitudinally fissured. This characteristic is, in my opinion, much more important than his remark about its pale colour, which seems to be only the case in the dry bushveld, whereas in the mist-belt area of Magoebas Kloof in the northern Transvaal, the bark of big trees is smooth, but blackish. The young leaflets of *A. natalitia* are rather hairy. I suspect, therefore, that *A. hirtella* E. Mey. is only a young and local variety or modification of *A. natalitia*, as, during the last twenty years of collecting in Zululand and Natal, I have never seen a specimen clearly distinct from *A. natalitia* and *A. karroo*, which could be named *A. hirtella*.

The descriptions of *A. hirtella* and *A. natalitia*, as given by E. Meyer, differ only in three points. The hairiness of *A. hirtella*; the glands which are between each pair of pinnae, in the case of *A. natalitia*, and only between the first and the last one in the case of *A. hirtella*; and the form of the apex of the pinnulae. These apices in *A. natalitia* are called obtuse, in *A. hirtella* "acutiusculi," i.e. somewhat acute. But as E. Meyer, in his description of *A. natalitia*, stresses the difference between it and *A. karroo*, in such a way that we must assume that the leaflets of *A. natalitia* are more acute than those of *A. karroo*, I cannot see an essential difference between the apices of *A. natalitia* and *A. hirtella*. All these three differences, which E. Meyer believed to exist between *A. natalitia* and *A. hirtella*, are so variable that the conceptions of *A. natalitia* and *A. hirtella* are comprehended in the wider conception of *A. natalitia* which I have gained during my 20 years' collecting in the lowveld of Natal and Zululand.

A final description of *A. natalitia* can only be given if more and better annotated material, as mentioned above, is available, so that all the spontaneous and well-established hybrids can be separated from the pure species. Such a pure stock will probably be found on the beaches of Zululand, where its habitat does not overlap the more inland *A. karroo*.

3. *A. inconflagrabilis* Gerstner n. sp.

A. karroo Hayne et *A. natalitia* E. Mey. affinis nimis. Frutex, circiter tribus usque ad septem pedibus altus. *Cortex* niger, fns. is. multis horizontalibus praeditus. *Truncus* 3—8 cm. diam. *Rami* prope a humo diffusi. *Stipulae* spinescentes. *Spinae* directae, albae, circiter 1 mm. latae basi et usque ad 20 mm. longi permanentes et paululum crescentes per annos tres. *Folia* circiter 9×4 cm. *Foliola* vel pinnae (5)—6—(10) parium, pinnulae 24—28 parium circiter 5×1 mm., lineares, apice acutiusculo paululum apiculato, basi cordata, rugosae et subnitentes. Inter parem pinnarum petiolo brevi proximarum seu remotissimarum nonnunquam sunt glandulae. *Flores* 3—6 in fasciculo axillari, globosi. *Capita* circiter 13 mm. diam., colore luteo. *Flosculi* calice et corolla glabris, lobatis, luteisque (cf. Fig.). *Filamenta* circiter 30, elongata, lutea. *Antherae* minutae, globosae, luteae. *Stylus* alboluteus, elongatus, simplex. *Legumen* fuscum, falcatum, repetitum constrictum, simile legumini *A. karroo*. Magnitudo leguminis variat. *Semina* 10×7 mm. longa vel lata adsunt 3—5 in legumine. *Frons* novella viscosa, glaberrima.

Habitat in the mist-belt area and transition from mist-belt to grassveld and bushveld, from 1,500 to 3,000 ft. *A. inconflagrabilis*, "The Fire-Resisting," sprouts out easily after veld fires. It was especially used by the Zulu king uShaka and others to fence the isigodlo (harem) of their kraals (homesteads). Its standard Zulu name is "isiKhombe". Others are isiKhombo, uSaku, and uGaku. The two latter names are used for *A. Borleae* Burt Davy as well, which has the same shape, glabrous and sticky surface, the very progressive expansion of the laxiflorous inflorescences, and the quality of easy regeneration after veld fires. *A. inconflagrabilis* is always a shrub and about 3—7 ft. high in contrast to its nearest relations, *A. karroo* (in Zulu umuNga) and *A. natalitia* (in Zulu umSama). The last two species grow into trees and inhabit the dry bushveld. *A. karroo*, the most common Acacia in Africa, has of course quite a number of synonymous names, which had to be sunk, e.g. *A. horrida* F.C., *A. capensis* Burch., *A. nilotica* Thunb. and also probably *A. seyal* Delisle.

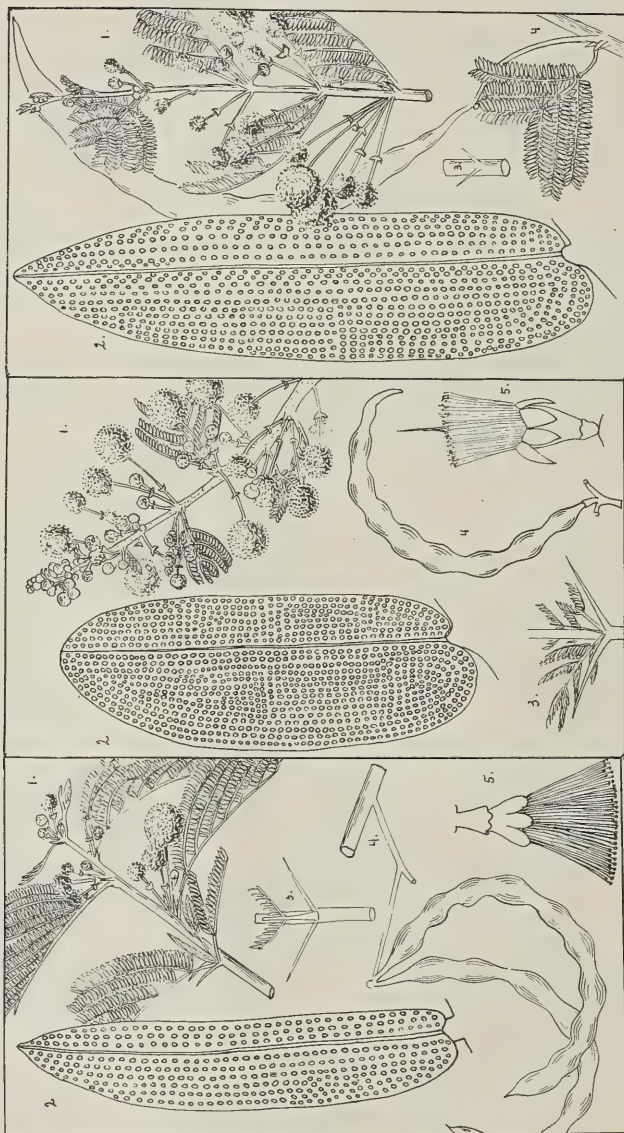
The Sotho tribes do not distinguish these nearly-related Acacias, and call the tree form just "Mookha," and the bushy forms, "Mookhana," in Basutoland itself, "Leokha". The two latter names are only diminutives of the first one.

The Europeans do not distinguish these three closely-related species either. *A. karroo* and its near relations are called in English: "Karoo Thorn," "Gum-arabic Tree," "Thorn Tree," "White Thorn," "Sweet Thorn," if it is eagerly eaten by stock, and "Sour Thorn," if the stock does not care for it. The name *Mimosa* (Tree) is, of course, an error. In Afrikaans they call these Acacias "Karroodoorn," "Doringboom," "Doornboom," "Kareedoorn," "Witdoring," "Soetdoorn," and "Soetdoring". *A. inconflagrabilis* is probably often called "Sour Thorn" or "Suurdoring," because in the Mist Belt areas, where it occurs, fresh grass is plentiful all the year round, so that cattle would not need to eat such prickly fodder.

The bark of *A. inconflagrabilis*, at first reddish, later turns black, and on the larger stems has small horizontal fissures. The trunk is at the bottom only 2—8 in. in diameter and always branches out near the soil. The stipules are transformed into straight, whitish spines 1—20 mm. long. They remain growing on the stem for three years, a feature which gives this species a very thorny appearance.

The primary leaves are about 9×4 cm. The 5—7 (mostly 6) paripinnate pinnae have 24—28 pairs of pinnulae. The pinnulae are 5×1 mm., linear, their apex acute, or even apiculate, especially if young, and the base cordate. The surface of the pinnulae as seen under a lens is rugose, and the whole frond has a shiny appearance. But it is not so shiny and sticky as *A. Borleae*, which has much smaller pinnulae in addition, and can, therefore, not be confused with any of our three closely related Acacias.

Between either the first or the last pair of pinnae, we often find an oval sessile or stalked gland, which serves to attract plant-protecting sugar ants. The inflorescences are 1—6, axillary, fasciculate, yellow, like the yolk of an egg, globose, about 13 mm. diameter: they more or less replace the secondary leaves of the axillary spurs. In the young inflorescence the involucrel is near the flowerhead, but when the flowers are fully expanded, the lobed involucrel is less than half way from the base of the slender, glabrous peduncle. Calyx, corolla, filaments and anthers (cf. figure) are all yellow. The brown, falcate, slightly torulose (constricted) legume is 80×8 mm. in size, and similar to that of *A. karroo*. The seeds (3—5) are about 5—10 mm., ovate, glabrous, blackish-brown, and shiny.

*Acacia inflativalis**Acacia karroo**Acacia natalia*1, 3 and 4 $\times \frac{1}{2}$.2 $\times$ c.20.5 $\times$ c.4

IV. TAXONOMIC SYNOPSIS.

	<i>A. karroo.</i>	<i>A. inconfagrabilis.</i>	<i>A. natalitia.</i>
Shape	plum-tree-shaped	shrub	pear-tree-shaped
Colour of bark	blackish	black when old	light grey
Surface of bark	vertically fissured and peeling off	horizontally furrowed when old, not peeling off	in young state, smooth, more or less rugose, later horizon- tally fissured, not peeling off
Expansion of inflorescence	almost simulta- neous	very progres- sive	progressive
Average size of pinnulae . .	4·5 × 1·5 mm.	5 × 0·75 mm.	5 × 1·4 mm.
Surface of pinnulae	dull	somewhat shiny	dull
Apex of pinnulae	round	acute or more or less apicu- late	acute
Base of pinnulae	subcordate and subsessile	cordate with short petio- lule	subcordate and subsessile

V. SPECIMENS.

Dried material of these three species, verified in the field by the author, has been placed in the National Herbarium, Pretoria, the Natal Herbarium, Durban, the Kirstenbosch Herbarium, the Bolus Herbarium of the University of Cape Town, and the Herbarium of the University College of Pietermaritzburg, viz.

A. karroo : Gerstner 4561, 4634, 4640 ;

A. natalitia : Gerstner 4332, 4526, 4529, 4639 and 5417 ;

A. inconfagrabilis : Gerstner 4562, 4635, 4637 and 5258.

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PLANTAE NOVAE AFRICANAE.

"Ex Africa semper aliquid novi."—*Pliny*.

SERIES XXVIII.

By MISS W. F. BARKER, MISS G. J. LEWIS, MRS. M. R. LEVYNS, and
the late DR. C. E. MOSS.

***Brunsvigia Comptonii* Barker.** (Amaryllidaceae.)

Bulbus oblongo-globosus, diam. c. 2.5 cm., apice collo producto. *Folia* 3—5, hysterantha, ovata, long. 3—4 cm., lat. 2—3 cm., subacuta vel obtusa, glabra. *Umbella* parva, 6—13-flora, diam. 6—12 cm. *Perianthii segmenta* long. 2—2.7 cm., lat. 4—5 mm., undulata vel plana, rosea. *Stamina* biseriata, longissima perianthio aequantia. *Ovarium* triquetrum. *Stylus* deinde stamine longior.

Hab. Cape Province. Laingsburg Division: Whitehill, crevices in Dwyka shale, 2,700 ft., *Compton* 20483 and *Nat. Bot. Gdns.* 145/48 (*Type*, in *Herb. Nat. Bot. Gardens*), flowers 5 March, 1948; *Compton* 13043, flowers 2 March, 1942; *Compton* 13245, leaves 15 June, 1942; *Compton* 14410, fruits 25 Feb., 1943; *Compton* 15608, flowers 20 March, 1944, *Nat. Bot. Gdns.* 91/44, leaves 26 June, 1944; Farm Hillandale near Matjesfontein, *Austin* in Marloth *Herb.* 11058 (in *Nat. Herb.*, Pretoria), buds Feb., 1922; Matjesfontein, *Frith* in Marloth *Herb.* 11612, flowers April, 1923.

Bulb oblong-globose, 3—4 cm. long, 2.5 cm. diam., rarely 4 cm. diam. when compressed, covered with brittle chestnut-coloured tunics, produced into a neck 2—7 cm. long. *Leaves* 3—5, hysteranthous, ad-

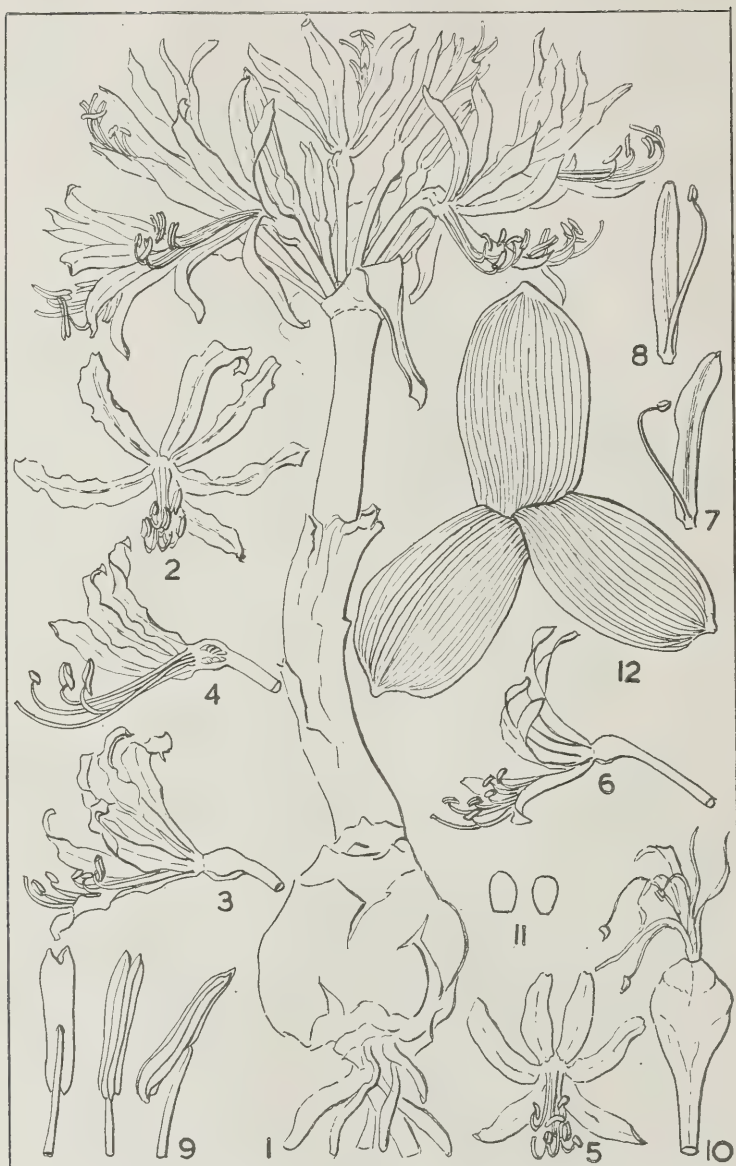


FIG. 1. *Brunsvigia Comptonii* Barker. 1. Plant in flower. 2. Flower with undulate segments, front view. 3. Flower, side view. 4. Longitudinal section of flower. 5. Flower with plain segments, front view. 6. Flower, side view. 7. Outer perianth segment with stamen attached. 8. Inner perianth segment with stamen attached. 9. Anther, back, front and side views $\times 3$. 10. Young capsule. 11. Seeds (*Compton* 20483, *Nat. Bot. Gdns.* 145/48). 12. Leaves (*Compton* 13245). All drawings natural size except where stated. *Del.* W. F. Barker.

pressed to the ground, ovate, subacute or obtuse, closely veined, glabrous, 3—4 cm. long, 2—3 cm. broad. *Umbel* small, 6—12 cm. diam., 6—13-flowered. *Peduncle* purplish-brown, flattened, 3—6 cm. long above the neck, 5—8 mm. diam. *Pedicels* greenish tinged purple-brown, 1·5—2·5 cm. long, lengthening a little in the fruiting stage. *Spathes* 2, papery, reddish or purplish, as long as or a little longer than the pedicels, rarely shorter. *Perianth segments* free almost to the base, all curving towards the top of the flower, or one remaining at the base, all sub-erect in the lower half, spreading to recurved in the upper half, greenish at the base, varying in colour from pale pink with a distinct midrib to deep pink with three darker central veins, the margins sometimes distinctly undulate, sometimes not, 2—2·7 cm. long, 4—5 mm. broad. *Stamens* declinate, biseriate, the three long ones as long as the perianth, their anthers maturing first, the three short ones three-quarters the length of the segments; filaments pale to deep pink, the base attached to the perianth segments sometimes with two minute appendages near the base. *Ovary* green tinged with purple-brown, three angled, 3—4 mm. long, 3 mm. diam. *Style* pale to deep pink, filiform, declinate, finally longer than the stamens. *Capsule* up to 1·5 cm. long, 1 cm. diam.; seeds pinkish, up to 5 mm. long.

While compiling a record of the Flora of Whitehill over a considerable number of years, Professor R. H. Compton made several collections of this interesting small *Brunsvigia*, which is named after him. The plants flowered very sparingly and the material collected was insufficient for making satisfactory illustrations. This year an expedition was made to coincide with its flowering period, the season proved to be an unusually good one, and it was found growing in profusion in the crevices of hard Dwyka shale, sometimes on steep slopes, the bulbs in many cases being compressed. As far as is known the range of the species is limited, as the only two other collections were made near Matjesfontein, which is close to the type locality.

The affinity of the plant is with *B. striata* Ait. and *B. radula* Ait. which are both small flowered species. It differs from the former by being less robust with shorter pedicels and the leaves smaller and adpressed to the ground, and from the latter by having leaves without raised papillae.

***Monadenia ecalcarata* Lewis sp. nov.**

M. conferta accedit sed foliis pluribus, floribus paulo majoribus et ovario haud spiraliter torto distinguitur.

Planta 15 cm. alta. Folia circa 10, erecta, imbricata, lanceolata, conduplicata, 4—10 cm. longa, 7—8 mm. lata. Spica 7 cm. longa, compacta, multiflora. Bracteae lanceolatae, acuminatae, 1—2 cm. longae,



FIG. 2. *Monadenia ecalcarata* 1. Plant, nat. size. 2. Flower, front view $\times 2$. 3. Bract and flower, side view $\times 2$. 4. Sepals and petals $\times 3$. 5. Top of ovary, stigma and rostellum, front view $\times 10$. 6. Top of ovary and anther, back view $\times 10$. 7. Pollinia $\times 15$. (Del. G. J. Lewis).

erectae apicibus incurvis. Flores juniores virides, seniores sepalo impari leviter sanguineo-suffuso. Sepala lateralia oblonga, subacuta, 4 mm. longa, patentia vel recurva marginibus recurvis: sepalum tertium ovatum, 4 mm. longum, 3 mm. latum, ecalcaratum, subarcuatum apice incurvo: petala lateralia oblique oblonga, obtusa, 3 mm. longa: labellum 3—4 mm. longum, 1 mm. latum, obtusum. Rostellum minutum, emarginatum: stigma subquadratum. Ovarium haud spiralter tortum, 9 mm. longum.

Hab. Cape Peninsula, on damp rocky northern slopes of Constantiaberg, near the top of Baviaans Kloof. 1500—2000 ft. *Lewis, South African Museum no. 58294 (Type, in S.A.M. Herbarium).*

Flowering season, October.

Nearest *M. conferta* but distinguished by the more numerous leaves, the colour and slightly larger size of the flowers and the untwisted ovary.

Plant 15 cm. high. Leaves about 10, erect, imbricate, closely sheathing at the base, lanceolate, conduplicate, 4—10 cm. long, 7—8 mm. wide. Spike 7 cm. long, dense, many-flowered. Bracts lanceolate, acuminate, 1—2 cm. long, erect with reddish incurved tips. Flowers green, the older ones with the odd sepal tinged with dull red. Side sepals oblong, subacute, 4 mm. long, spreading or recurved with recurved margins: odd sepal spurless, slightly concave at the base, ovate, acute, 4 mm. long, 3 mm. wide, slightly arched with the tip incurved: petals obliquely oblong, obtuse, 3 mm. long, fleshy: lip strap-shaped, obtuse, 3—4 mm. long, 1 mm. wide, slightly fleshy. Rostellum very small, erect, emarginate, concave in front: stigma nearly square, cushion-like: connective of the anthers very short. Ovary cylindrical, not twisted, slightly curved near the top, 9 mm. long.

The habit and floral structure of the species figured and described here are those of the genus *Monadenia*, to which there is little doubt that it belongs, but it is unique in the genus in not having the ovary twisted, so that the flowers, instead of facing outwards, all face in towards the stem. With the exception of *M. conferta*, all the previously described species have a short or long spur at the base of the odd sepal. In the number, arrangement and colouring of the leaves and the size and appearance of the plant *M. ecalcarata* superficially resembles *M. micrantha*, a common and fairly widely distributed species, with which it was found growing.

A considerable number of the terrestrial Orchids of South Africa are extremely sporadic in their appearance, many of them only flowering after fires. The fact that this species was discovered for the first time in October of this year, on a mountain slope that had been burned at the end of the previous year, indicates that it is one of these. In spite of

extensive searching in the vicinity only one plant of this rare and interesting new species was found.

Watsonia tabularis Mathews and L. Bolus var. **concolor** Lewis var. nov.

A typo floribus rubris vel rutilis, segmentis concoloris interioribus quam typicis angustioribus, differt.

Hab. Cape Peninsula, Redhill, *Salter* 1896 (S.A.M. and B.H.) type; *Penfold*, S.A.M. 52169; Simonstown Mtns., *Minicki*, S.A.M. 51365; Kenilworth Race Course, *Salter* 7153 (S.A.M. 52767); Silvermine Valley, *Linley*, S.A.M. 57351; Steenberg Plateau, *Lewis*, S.A.M. 57379; Smitswinkel, *Salter* 4265; Cirkels Vlei, *Salter*, B.H. 20427; Muizenberg, *Bolus* 4627.

Flowers scarlet or orange-red, the inner perianth lobes the same colour as the outer, narrower than in the typical. Perianth tube 4·5—5·5 cm. long: outer perianth lobes oblong, shortly acute, 2·2—3·2 cm. long, the inner obovate, 2·5—3·5 cm. long, 1·5—2 cm. wide.

Flowering season not very definite, usually December—February.

In the typical *W. tabularis* the flowers are deep rose or coral-pink, the inner perianth lobes pale salmon or rose-pink. It occurs only from the top of Table Mt. to Vlakkenberg. The variety occurs on the mountains from Vlakkenberg to Kalk Bay, on the flats at Kenilworth and in marshy places from Redhill to Cape Point, where it is fairly common. The Vlakkenberg is the only place where the typical and the variety occur together and a form, evidently a cross between these, has been recorded from this mountain.

Homoglossum Merianellum (L.) Baker var. **aureum** Lewis var. nov.

A typo floribus aureis et serotino tempore florente differt.

Hab. Cape Peninsula, between Scarborough and Klaasjagers, on recently burned marshy ground, *Linley*, S.A.M. 58293 (type); southern end of the Cape Peninsula, *Darroll*, B. H. 17283.

This variety differs from the typical in the colour of the flowers and the later flowering period. The flowers vary from golden-orange, tinged with red, to pure golden-yellow, the three lower perianth lobes often spotted with red near the base. The typical *Homoglossum Merianellum* flowers during the winter, from April to July or early August, whereas the variety is spring-flowering, from September to October. Both are endemic in the southern part of the Cape Peninsula.

Selago cylindrica Levyns sp. nov.

Selago scabrata Thunb. affinis sed spicis elongatis cylindricis, floribus minoribus et corollis glabris angustioribus differt.



FIG. 3. *Selago cylindrica*. 1. Flowering branch $\times 2$. 2. Single flower with its bract $\times 10$. (Del. M. R. Levyns.)

An erect branching shrub, 20—35 cm. high. Stems hispid. Leaves 5—8 mm. long, linear or elliptical, somewhat revolute, sparsely hispid, crowded and fascicled. Flowers white, crowded in cylindrical spikes arranged in rather scanty corymbs. Bracts linear, somewhat acute, hispid, 2·8 mm. long or somewhat less. Calyx about 2 mm. long, hispid, the linear lobes a little longer than the tube. Corolla tube slender, glabrous, about 3·5 mm. long and 0·5 mm. wide, the anterior lobe about 2 mm. long, the others a little shorter, all lobes oblong, obtuse. Style minutely scabrous. Ovary glabrous.

Hab. Cape Province. Cape Division: Cape Point, *Levy's* 5418 (*Type* in Bolus Herbarium): Swellendam Division: *Bolus* 8072.

Bolus 8072 is cited in the *Flora Capensis* under *Selago scabrida* Thunb. The present species differs from *Selago scabrida* in its long cylindrical spikes, its much smaller flowers and the glabrous corolla with narrow lobes.

(*Note by Professor R. S. Adamson.*—The late Professor C. E. Moss had been engaged for some years before his death on a revision of the African species of *Salicornieae*. Unfortunately his results were incomplete. While it is hoped that the monograph based on his notes and memoranda may be published in due course, delay is inevitable. Meanwhile in view of the publication in the immediate future of the *Flora of the Cape Peninsula*, it seems desirable to publish at once the species that occur there. Another reason for immediate publication of these species is that manuscript names were added to specimens examined by their author and some of these have been included in publications. The following descriptions are practically as they were drawn up by their author.)

Salicornia Meyeriana* Moss *sp. nov.

Annua, debilis, atro-viridis vel atro-coccinea, erecta vel decumbens, plerumque ramosa, ramis divaricatis vel subfastigiatis. Foliorum apices in vivo appressi, saepius atro-rubri. Spicae maturae cylindricae, segmentis fertilibus circa 10. Cymae triflorae, flore medio acute quadrangulare lateralibus duplo longiore, lateralibus a medio poene separatis. Semina pilosa, pilis appressis apice circinatis.

Stems slender, rarely over 10 cm. long, much branched. Segments up to 1 cm. long, falling easily and only the youngest parts succulent. Spikes on both the main and lateral branches, 1—2·5 cm. long, tapering when young. The flowers of the cymule apparent at anthesis, the central longer than and almost separating the lateral. Seeds 1 mm. by 0·5 mm., covered with long appressed hairs coiled at the tips.

Salt marshes and tidal estuaries.

Hab. Without exact locality, *Sparrman* (in *Herb. Linn.* as *S. herbacea*).

Cape Province. Cape : Paarden Is., *Drege* 226 ; *Moss* 5251, 8760, 8783, 10108, 10109 ; *Levy* in *Herb. Moss* 16909 (*type*) ; *Adamson* 846, 2851 ; *Schlechter* 254 (barren). Bredasdorp : Struis Bay, *Levy* 3536. George : Little Braak Riv., *Moss* 4346 ; Great Braak Riv., *L. Bolus* in *Herb. Bolus* 18807. Knysna : Knysna, *Duthie* 884, 884a, 902. Port Elizabeth : *E. M. Young* in *Herb. Moss* 17001. Bathurst : Kowie, *Britten* 2862, 5197.

Natal. Durban, *Moss* 4336, 5252.

Madagascar. *Scott-Elliott* (s. no.).

The species is named in honour of F. W. Meyer who first named *S. African Salicornias*. The plant has commonly been referred to *S. herbacea*.

Arthrocnemum africanum* Moss *sp. nov.

Suffruticosa, prostrata, ramosissima, ramis ascendentibus. Caules basi tantum lignosa. Segmenta succulenta, subconica, glabra, nitida, viridia vel colorata, foliis appressis, marginibus foliorum bractearumque pallidis in sicco cartilagineis. Spicae cylindricae, obtusae segmentis fertilibus brevibus numerosis. Cymae triflorae, lateraliter distantes, floribus bracteis obscuris vel minime superantibus. Flores contigui, flore medio lateralibus paulo longiore. Semina punctulata.

A prostrate glabrous slightly woody perennial though often flowering in the first year. Shoots succulent, shining, up to 50 cm. long, variously coloured, green, pink, red, brown or purple, the colour appearing diluted owing to the transparent epidermis. Segments slightly widened upwards, the leaf tips appressed, paler in colour and cartilaginous when dry. Spikes with 10—20 segments each about 2—3 mm. long. Flowers almost hidden, usually red, the central very slightly longer than the lateral. Cymules with a distinct lateral space. Seeds rounded, punctulate, not hairy.

Common in the S.W. districts on damp salty soils both by the sea and some distance inland.

Hab. Cape Province. Cape : Rugby, *Moss* ; Uitvlugt, *Wolley-Dod* 2091 ; Raapenberg, *Bolus* 3708 ; *Wolley-Dod* 2398 ; *Guthrie* 1312 ; Noordhoek, *Adamson* ; Muizenberg, *Michell* ; *Wolley-Dod* 976, 3590 ; Lakeside, *Page* ; Fish Hoek, *Moss* 14243 (*type*). Bredasdorp : Struis Bay, *Levy* 3537. Swellendam : Slang Riv., *Adamson*. George : Wilderness, *Stephens* (18839 in *Herb. Bolus*). Knysna : Knysna, *Duthie* (18838 in *Herb. Bolus*) ; *Fourcade* 1997 (partly).

The commonest Cape species. It has hitherto been referred to *S. natalensis* Bunge.

Arthrocnemum littoreum* Moss *sp. nov.

Suffrutex 0·6—1 mm. altus, erectus, ramis erectis numerosis fastigiatis nunquam radicanibus. Segmenta carnosa. Cymae triflorae rarissime 4 vel 5-florae, floribus lateraliter contiguus. Flos medius ceteris longior, segmenti dimidio longior. Semina pilosa, pilis circinatis patentibus.

Stems woody, up to 4 cm. diam. at the base, not rooting at the nodes, the upper parts very fleshy, subglaucous, rarely red. Leaf tips appressed when fresh, spreading when dry. Spikes thick, cylindrical, terminal on the main stem and short subapical branches, up to 10 cm. long and 0·8 cm. diam. Flowers contiguous when fresh, the central longer than and completely separating the lateral. Mature seeds with spreading hairs coiled at the tips.

Frequent on salt-sprayed rocks, not on mud.

Hab. Cape Province. Namaqualand: Hondeklip Bay, *Pillans* in Herb. Bolus 18216, 18217; Cape: Robben Island, *Marloth*; Camp's Bay, *Wolley-Dod* 3056; *Marloth* 8917; *Moss* 3132, 8765, 8775 (*type* in Herb. Moss); *Prior*; *Page* in Herb. Bolus; Hout Bay, *Harvey* 194; Kalk Bay, *Pillans* 3247; Caledon: Mossel Riv., *Guthrie* in Herb. Bolus 17210. Bredasdorp: Cape Agulhas, *Salter* 4128. Riversdale: Kafir Kuils Riv., *Muir* 3149; Still Bay, *Muir* 5294. Mossel Bay: *Moss*, 4341; *Burtt-Davy* 15639. Knysna: Knysna Heads *Adamson* in Herb. Moss 8763; Plettenberg Bay, *Smart* in Herb. Rogers. Port Elizabeth: Cape Recief, *Burchell* 4398; Pt. Elizabeth, *Lurie* in Herb. Moss 18181; *Walmer*; *E. M. Young* in Herb. Moss 17002.

This is the plant referred to *S. fruticosa* in Flor. Cap. It is distinguished by its more erect habit, more robust growth, fastigate branches, very long spikes and hairy seeds without endosperm. The habitat is unique in the genus.

Arthrocnemum Pillansii* Moss *sp. nov.

Arbusculus ascendens vel tandem decumbens, caulibus compressis. Segmenta carnosa, glauca. Spicae maturae cylindricae, spicis lateralibus brevioribus pluribus. Cymae triflorae. Flos medius lateralibus longior, segmenti dimidio aequans. Semina pilosa, pilis conicis apice non circinatis.

Shrubby, either ascending up to 15 cm. high or decumbent with much flattened woody stems, 1—2 m. long. Branches succulent at the tips only, glaucous, often red. Spikes 3—6 cm. long. Central flower larger

than and wholly separating the lateral. Seeds minutely punctulate, when mature covered with stout straight spreading conical hairs.

Salt marshes along the S. and S.W. coasts.

Hab. Cape Province. Cape : Salt River, *Moss* 3141 ; Rugby, *Moss* 8764 (*type* in Herb. *Moss*), 9790 ; *Adamson* 917, 2852. Bredasdorp : Struis Bay *Levy* 3535. Swellendam : Slang Riv., *Adamson*. George : Great Braak Riv., *L. Bolus* in Herb. *Bolus* 18840. Knysna : Knysna, *Duthie* 885, 885a, 885b. Port Elizabeth : Redhouse, *Moss* 10016 ; Port Elizabeth, *Stephens* in Herb. *Bolus* 18840. Bathurst : Port Alfred, *Britten* 1438, 2096 ; Kowie East, *Britten* 5198, 5203.

Arthrocnemum capense* Moss *sp. nov.

Suffrutex ramosus, ramis sterilibus prostratis, fertilibus erectis. Segments viridia vel rubra, apicibus foliorum appressis. Spicae cylindricae, obtusae. Cymae triflorae, lateraliter approximatae. Flos medius segmento subaequans floribus lateralibus paulo longior. Semina pilosa, pilis conicis patulis apice circinatis.

A small undershrub with brittle branches, the prostrate barren branches not or very occasionally rooting at the nodes. Segments rather thin. Spikes obtuse, cylindrical, up to 7 cm. long. Flowers when dry distinctly separated, the barren spaces between the cymules very small. Seeds hairy with conical spreading hairs coiled at the tips.

A local species at present only known from the vicinity of Cape Town where it is common on the drier parts of salt marshes.

Hab. Cape Province. Cape : Milnerton, *Moss* 11621 (*type* in Herb. *Moss*) ; *Adamson* 847 ; Uitvlugt, *Wolley-Dod* 480 ; Raapenberg, *Wolley-Dod* 2690 ; Noordhoek, *Moss* 3133, 3144 ; *Adamson* ; *Pillans* 3222 ; Muizenberg, *Michell* ; Riet Vlei, *Pillans* 3229 (barren).

Without exact locality *Wallick* 350 (partly) ; *Harvey* 449 (barren).

Arthrocnemum variiflorum* Moss *sp. nov.

Arbusculus procumbens ramis suberectis. Spicae maturae obtusae segmentis incrassatis. Cymae inferiores 5-florae, contiguae, superiores 3-florae paulo distantes. Flos medius ceteris longior, segmenti dimidio distincte longior, floribus lateralibus distantibus. Semina oblongo-elliptica, pilosa, pilis conicis apice circinatis.

Procumbent shoots woody up to 45 cm. long. Segments brown, cork-like. Spikes 3—3.5 cm. long, obtuse, the fertile segments swollen, the basal segment often with 1 cymule, the lower with 5-flowered contiguous cymules, the upper with 3-flowered separated cymules.

Salt marshes.

Hab. Cape Province. Cape : Milnerton, *Moss* 8765 (*type* in Herb.

Moss) 8776; *Levy*ns; *Adamson* 920, 2853. Riversdale: Still Bay, *Muir* 166. Knysna: *Knysna*, *Adamson* in Herb. Moss 9937; *Duthie*.

The following new combination is also made :—

Arthrocnemum perenne (Mill.) Moss *comb. nov.*

Salicornia perennis Mill. Gard. Diet. ed. 8, no. 2, 1768; Moss in *Journ. Bot.*, 49. 179. 1911.

var. a. ***lignosum*** Moss *comb. nov.*

S. lignosa Woods Bot. Gaz. 3. 31. 1851.

var. b. ***radicans*** Moss *comb. nov.*

S. radicans Sm. Eng. Bot. t.1691. 1807.

S. fruticosa var. *radicans* Moq. Chen. Enum. 112. 1840.

S. fruticosa var. *paardeneilandica* Ung.-Sternb. Vers. Syst. Salic., 59. 1866.

S. perennis var. *radicans* Moss and Salisbury Camb. Brit. Fl. 2. 188. t.195. 1914.

Only the var. *radicans* occurs in S. Africa.

SOME NEW SPECIES AND VARIETIES IN THE GENUS HAWORTHIA VI.

(With Plates VII and VIII.)

By G. G. SMITH.

Haworthia atro-fusca, G. G. Smith. (Liliaceae-Aloineae) Sect. Retusae.

Rosetta acaulescens, diam. usque ad 65 mm.

Folia 20 circiter, longa usque ad 40 mm., lata 17 mm., oblongata, acuta vel deltoidea; *seta extrema* longa 3 mm., non denticulata, brevi tempore decidua; *pars retusa* longa 17 mm. vel longior, multis parvis tuberculis concoloribus ornata, obscure fusca, serius tempore rubra, lineis 3—5 atro-fuscis indistinctis percursa; *subtus* convexa, basim prope viridia, apicem versus atro-fusca.

Pedunculus diam. $1\frac{1}{4}$ mm., longus una cum racemo 21 cm.; *pedicelli* longi 1 mm., diam. 1 mm.; *perianthium* opace album, longum 14 mm.; *ovarium* longum $2\frac{3}{4}$ mm., diam. 1 mm., viride; *stylus* longus $\frac{3}{4}$ mm., obflexus, capitatus.

Rosette acaulescent, up to 65 mm. diam., not or slowly proliferous.

Leaves about 20, the young erect, the old ascending-erect, retused at an angle of about 90 degrees, firm, up to 40 mm. long, 17 mm. broad at base of end-area to base of leaf, 11 mm. thick at base of end-area, oblong, acute to deltoid; *end-awn* inconspicuous, 3 mm. long, naked, concolorous, soon deciduous; *face below end-area* flat to concave, smooth, green at base, dark reddish-brown below end-area, dull; *end-area* 17 mm. long and longer, 17 mm. broad, flat-convex, $\pm$ turgid, beset with many small concolorous tubercles becoming minute at tip of leaf and at base of end-area, dark brown, becoming red with age, $\pm$ shining, with 3—5 indistinct dark reddish-brown lines, the middle one extending about half-way up the end-area, the others progressively shorter; *back* convex, smooth but with a few small concolorous tubercles near the end-area margins, green at base, dark reddish-brown above, dull, with about 16 indistinct lines; *keel* 1, central, in the upper $\frac{1}{4}$, with a few small concolorous teeth; *margins* acute below, $\pm$ rounded above, with small pellucid white teeth, becoming minute towards the base of leaf.

Peduncle simple, $\pm$ terete, $1\frac{1}{4}$ mm. diam., 21 cm. long including the few-flowered raceme, light brown below; *raceme* 7 cm. long, about 15

spirally arranged flowers and buds, 1—2 open simultaneously; *pedicels* 1 mm. long, 1 mm. diam., dark brownish-green; *sterile bracts* 18, 9 mm. long, the lowest about $\frac{1}{2}$ cm. from base of peduncle; *fertile bracts* 9 mm. long, broadly lanceolate, acuminate, white with a reddish-brown nerve; *perianth* dull white, 14 mm. long, the cylindrical-triangular base 3 mm. diam., tapering to 2 mm. above, ascending, curved; *upper segments* narrow obtuse, recurved-revolute, the outer ones replicate above, hardly spreading, the face colour dull white with a dark brown medium fine nerve, the inner segment channelled, $\pm$ shorter, face colour dull white with a dark greenish-brown broad nerve; *lower segments* obtuse, recurved about 90 degrees, the outer ones replicate, hardly spreading, face colour dull white with a dull greenish-brown broad nerve, the inner segment channelled, face colour white with a dark brown medium-fine nerve; *stamens* 4 and 5 mm. long; *ovary* $2\frac{3}{4}$ mm. long, 1 mm. diam., green; *style* $\frac{3}{4}$ mm. long, greenish-white, bent, capitate.

Habitat: Cape Province: Riversdale Dist. (Type, G. G. Smith 6169 (*Dekenah* 225) in East London Museum Herbarium.)

Distribution: not further known.

This very distinct species was collected by Mr. J. Dekenah between Riversdale and Heidelberg, and sent to the author in Nov., 1945. He reports that although the veld was in very good condition when he found the plants, they were, although well shaded, all of a reddish-brown colour.

The plant is aptly called "*atro-fusca*", because of its dark reddish-brown colour. It is quite distinct from all species in the Sect. *Retusae*.

Haworthia heidelbergensis, G. G. Smith. (Liliaceae-Aloineae.) Sect. *Retusae*.

Rosetta acaulescens, usque ad 7 cm. diam., a basi proliferans.

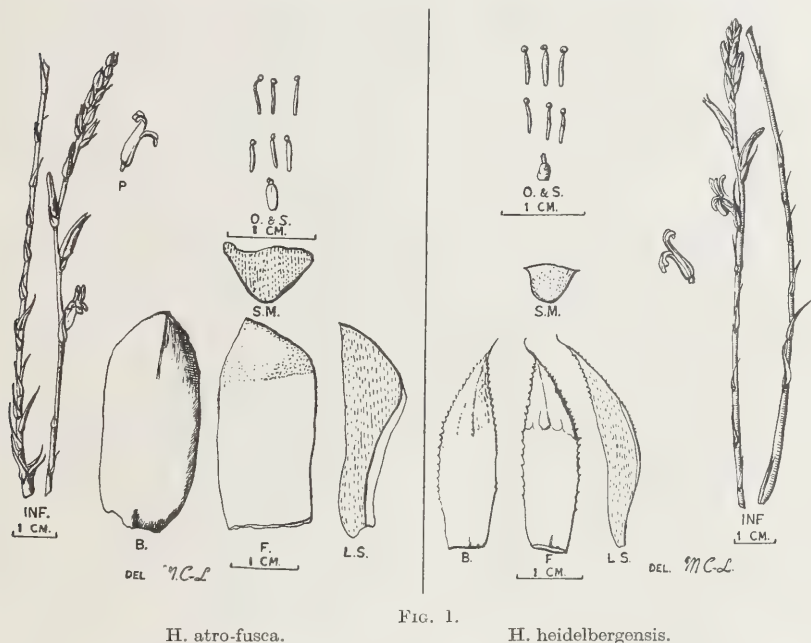
Folia circiter 35, longa usque ad 35 mm., lata 8 mm., obovato-oblongata, acuminata; *pars retusa* longa 16 mm., lata 8 mm., convexa, plana; *subtus* planus vel paucis concoloribus, maxime pars denticulatis tuberculis; *carina marginesque* dentibus lucidis $\frac{3}{4}$ mm. longis.

Pedunculus simplex, diam. 1 mm., una cum racemo longa circiter 25 cm.; *pedicelli* longi 1 mm., diam. 1 mm.; *perianthium* album, longum 14 mm.

Rosette acaulescent, up to 7 cm. diam., proliferous from the base.

Leaves about 35, the young light green, becoming darker green with age, the young erect $\pm$ recurved, the old spreading $\pm$ recurved and $\pm$ incurved at tips, $\pm$ tender, up to 35 mm. long, 8 mm. broad and 6 mm.

thick at base of end-area, obovate-oblong, acuminate, with a distinct naked persistent whitish-pellucid $\frac{3}{4}$ —5 mm. long end-awn; *face* above *end-area* flat below, convex above, smooth, pale green at base, darker above; *end-area* up to 16 mm. long, 8 mm. broad, convex, smooth, bluish pellucid green, hardly shining, with 3(—4) light green $\pm$ parallel lines (on some leaves only one line shows in the pellucid part) the middle line longer and sometimes nearly reaching the leaf tip; *back* convex, smooth



H. atro-fusca.

H. heidelbergensis.

or with a few concolorous, mostly toothed tubercles about the middle of the leaf, usually in one or more rows in the form of false keels, with few to many longitudinally oblong pellucid spots in the upper $\frac{1}{2}$, light green below, darker green above, dull, with many (about 10) indistinct lines; *keel* 1(—2) central in the upper $\frac{1}{3}$, acute above, with a few $\frac{3}{4}$ mm. long pellucid teeth towards the tip; *margins* acute, the pellucid teeth $\frac{3}{4}$ mm. long about the middle of the leaf, becoming smaller towards the base and tip.

Peduncle simple, terete, 1 mm. diam., including the raceme about 25 cm. long, greyish-brown below; *raceme* 5 cm. long, about 12 spirally arranged flowers and buds, 1(—2) open at a time; *pedicels* 1 mm. long, 1 mm.

diam., dark brownish-green ; *sterile bracts* about 15, the lower ones about 10 mm. long including the long awn, the lowest about $2\frac{1}{2}$ cm. from base of peduncle ; *fertile bracts* 8 mm. long, deltoid acuminate, white with a medium-fine reddish-brown nerve ; *perianth* white, light brown nerved, 14 mm. long, the cylindrical-triangular base 3 mm. across, gradually tapering to 2 mm. at the upper end of tube, ascending, curved ; *upper segments* obtuse, channelled, very recurved, face colour of the 2 outer white, with a medium-fine reddish-brown nerve, spreading, $\pm$ replicate towards tip, face colour of inner segment white at tip, dull white to pinkish-brown below, shorter than the outer ; *lower segments* obtuse, face colour of the 2 outer white with a fine green nerve which becomes pink towards the tip, deeply channelled, very recurved, spreading, replicate towards the tip, face colour of inner segment white, with a broad nerve, channelled, very recurved, much longer than the outer segments ; *stamens* 5 and $4\frac{1}{2}$ mm. long ; *ovary* $2\frac{1}{2}$ mm. long, fully 1 mm. diam., green ; *style* barely 1 mm. long, white, bent, not capitate.

Habitat : Cape Province ; Swellendam Dist. (Type, G. G. Smith 6566 in East London Museum Herbarium).

Distribution : also from Riversdale Dist.

This species is described from material collected by Mr. J. Dekenah (No. 230) of Riversdale, a few miles from Heidelberg. Its distribution appears to be restricted to or near the type locality, where it has been found by several collectors. *H. heidelbergensis* G. G. Smith is an attractive small species similar in general appearance to *H. mirabilis* Haw. but the leaves are narrower, margins not as conspicuously toothed, back of leaf not as tubercled and the colour quite distinct.

Haworthia longiana var. albinota, G. G. Smith. (Liliaceae-Aloineae.)
Sect. Margaritiferae.

Planta acaulescens, a basi proliferans.

Folia longa usque ad 28 cm., basi usque ad 28 mm. lata, lanceolata, acuminata, subulata ; *supra* plana, concava cum paucis v. pluribus tuberculis non conspicuis ; *subtus* convexa, apicem versus pallide viridia basin versus pulliora, tuberculis multis cum orbiculatis, oblongatis, confluentibus albidis, oblique carinatus.

Pedunculus simplex, diam. $2\frac{1}{2}$ mm., una cum racemo longus usque ad 60 cm. ; *racemus* floribus flosculisque tortuose circiter 40 ornatus ; *pedicelli* longi $3\frac{1}{2}$ mm. ; *bractae* steriles 4—6 ; *bractae* fertiles $5\frac{1}{2}$ mm. longae ; *perianthium* lineis viridibus albidum, longum $17\frac{1}{2}$ mm., diam. basi 4 mm.

Plant acaulescent, up to 32 cm. tall, the leaves at the apex spreading to about 18 cm. diam., proliferous from the base and forming clumps of about 2—6 plants.

Leaves about 24, ascending (in the clumps the leaves on each plant are bent away from one another), firm, up to 30 cm. long, up to 28 mm. broad at the base, 4 mm. thick at middle of leaf, lanceolate, acuminate-subulate; *face* concave, smooth, with a raised concolorous line in the lower $\frac{3}{4}$, and beset with few to many inconspicuous, small, whitish round tubercles, the old leaves bright light green towards the apex, darker dull green below, the young light green towards the apex, light bluish green below; *back* convex, pale green towards the apex, darker green below, beset with many round and oblong bluish-white, up to $1\frac{1}{4}$ mm. diam. tubercles on some plants, to about $\frac{1}{2}$ mm. diam. on others, many of the tubercles confluent, in some cases in all directions, in others forming irregular transverse bands, the tubercles very conspicuous in the lower $\frac{3}{4}$ of leaf, less conspicuous above due to the lighter green colour of this part of the leaf, obliquely keeled from near the base to the tip, margins acute.

Peduncle simple, $\pm$ terete, $2\frac{1}{2}$ mm. diam., including the raceme up to 60 cm. long, very pale green below, becoming light glaucous green above; *raceme* up to 12 cm. long, about 40 spirally arranged flowers and buds, 2—4 open simultaneously; *pedicels* $3\frac{1}{2}$ mm. long, 1 mm. diam., erect, light glaucous green; *sterile bracts* 4—6, the lowest about 26 cm. from base of peduncle, $8\frac{1}{2}$ mm. long including the awn; *fertile bracts* $5\frac{1}{2}$ mm. long, deltoid-lanceolate, subulate, white with a nerve which is bright green and broad below, becoming greenish-brown and fine above; *perianth* white, greenish nerved, $17\frac{1}{2}$ mm. long, the cylindrical-hexagonal sub-globose base 4 mm. diam., and tapering to the pedicel, constricted to $3\frac{1}{2}$ mm. above, oblong, ascending, curved; *upper segments* channelled, the 2 outer obtuse, very recurved, face colour white with a broad green nerve, the inner segment narrow obtuse, less recurved, face colour white at tip, light green below, with a broad very green nerve; *lower segments* obtuse, channelled, the 2 outer very recurved, replicate, face colour white at tip, light green below, with a medium broad very green nerve, the inner segment revolute, face colour white with a medium broad green nerve; *stamens* 7 and $5\frac{1}{2}$ mm. long; *ovary* $3\frac{1}{2}$ mm. long, $1\frac{1}{2}$ mm. diam., ovate, bright green; *style* $1\frac{1}{4}$ mm. long, green, with whitish tip, straight, not capitate.

Habitat: Cape Province; Humansdorp Dist. (Type, G. G. Smith 7070, in East London Museum Herbarium.)

Distribution: not further known.

This distinctive variety is described from material collected by the author in Dec., 1947, near Mistkraal in the Humansdorp Dist., about 8 miles N.W. of the type locality for *H. longiana* v.P. Of the many plants of this species examined in the field, at the type and other localities, and in gardens, the tubercles on back of leaf are concolorous or at the most only slightly whitish. In the new variety the tubercles are conspicuously large and bluish white. In the shade the plants become very tall and in general appearance are not as white looking as the smaller ones in the sun. The fully exposed plants have the appearance of being covered with white scale.

Haworthia viscosa var. quaggaensis, G. G. Smith. (Liliaceae-Aloineae.)
Sect. Trifariae.

Caulis foliatus altus 9 cm., latus una cum foliis 35 mm., a basi proliferans.

Folia tortuose trifaria, longa 27 mm., lata 12 mm., ovato-lanceolata, acuto-acuminata; *supra* basi concava, apice plana vel concavo-striata, basim versus claro-viridia, apicem versus obscure viridia, $\pm$ nitentia; *subtus* convexa, apicem prope triquetra, basi clare fuscido-viridia, apice valde obscure viridia, $\pm$ nitentia.

Pedunculus diam. $\frac{3}{4}$ mm., longus una cum racemo 22 cm., basi rubro-viridis; *pedicelli* longi $4\frac{1}{2}$ mm., diam. $\frac{5}{8}$ mm., virides; *perianthium* album, longum 17 mm.; *ovarium* longum $2\frac{1}{2}$ mm., diam. $1\frac{1}{4}$ mm., viride; *stylus* longus $2\frac{1}{2}$ mm., gilvo-viridis, capitatus.

Leafy stem erect (—ascending) up to 9 cm. long, 35 mm. across including the leaves, proliferous from the base.

Leaves imbricated, spirally trifarious, 27 mm. long, 12 mm. broad and $6\frac{1}{2}$ mm. thick at middle, ovate-lanceolate, acute-acuminate, cuspidate, the old less recurved than the young, the sheathing leaf base 4 mm. long on the side opposite to the lamina; *face* $\pm$ concave below, the old flat-concave, the young triangular-concave, minutely scabrous in the upper $\frac{1}{2}$, light green below, dark green above, $\pm$ shining; *back* rounded, triangular near the tip, minutely scabrous in the upper $\frac{2}{3}$, with 11 reticulate lines, light brownish-green below, very dark green above, $\pm$ shining; *keel* 1, $\pm$ obliquely arranged in the upper $\frac{1}{2}$, obtuse below, acute above, horny near the tip; *margins* acute below, $\pm$ rounded above, less scabrous than the leaf, horny, light greenish, reddish towards tip.

Peduncle simple, terete, fully $\frac{3}{4}$ mm. diam., 22 cm. long including the raceme, reddish-brown below; raceme $8\frac{1}{2}$ cm. long, about 12 flowers and buds, 1—2 open at a time; *pedicels* $4\frac{1}{2}$ mm. long, $\frac{5}{8}$ mm. diam., green; *sterile bracts* 1, 4 mm. long, 9 cm. above base of peduncle; *fertile bracts* $3\frac{1}{2}$ mm.

long, deltoid, acuminate-subulate, white with a fine reddish-brown nerve ;
perianth white, 17 mm. long, the cylindrical-hexagonal base 3 mm. diam.,
 slightly constricted above, ascending, not curved ; *upper segments* obtuse,

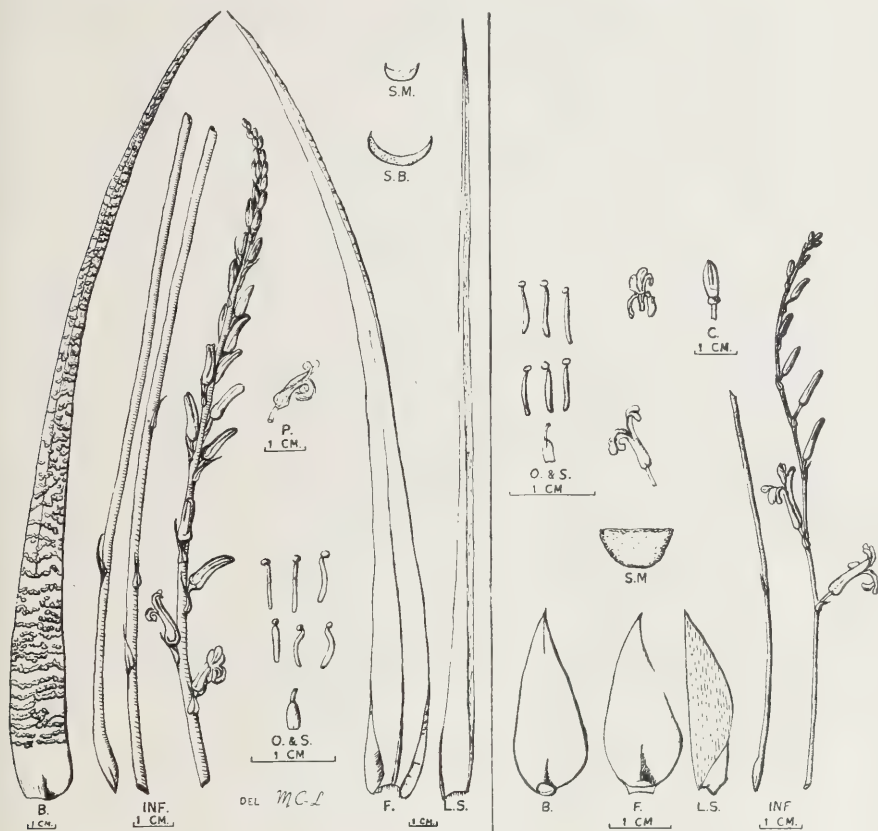


FIG. 2.

H. longiana var. *albinota*.

H. viscosa var. *quaggaensis*.

channelled, the face colour of the outer ones white with a medium fine nerve which is red at tip and green below, recurved, spreading, face colour of the inner segment white at tip, pale green below, with a medium fine nerve which is reddish at tip and greenish-brown below, not or hardly recurved with the tip incurved ; *lower segments* obtuse, very recurved,

face colour white, each with a medium fine nerve which is red at tip and green below, the outer segments replicate, very spreading, the inner one channelled; *stamens* 6 and 7 mm. long; *ovary* $2\frac{1}{2}$ mm. long, $1\frac{1}{4}$ mm. diam., green; *style* $2\frac{1}{8}$ mm. long; yellowish-green, $\pm$ bent, capitate.

Habitat: Cape Province; Humansdorp Dist. (Type, G. G. Smith 2937, in East London Museum Herbarium.)

Distribution: not further known.

This variety is described from plants collected by the author near Quagga, in the Humansdorp Dist., in Nov., 1939. Compared with the species, it is a heavier and more compact plant, the leaves not as lanceolate and more recurved, and the face not as concave.

Haworthia angustifolia var. paucifolia, G. G. Smith. (Liliaceae-Aloineae.) Sect. Loratae.

Planta acaulescens, a basi non vel lente proliferans.

Folia circiter 12, longa usque ad 5 cm., basi 9 mm. lata, lanceolata, acuminata; *supra* subtusque laevia, fuscido viridia; *carina marginesque* denticulati.

Pedunculus simplex, diam. $\frac{3}{4}$ mm., una cum racemo longus usque ad 18 cm.; *racemus* floribus flosculisque circiter 6—8-natis; *pedicelli* longi $1\frac{1}{2}$ mm., diam. $\frac{3}{4}$ mm.; *bractae steriles* circiter 12; *bractae fertiles* longae 3 mm.; *perianthium* album longum 14 mm.

Plant acaulescent, not or slowly proliferous from the base, up to 6 cm. tall, about 20 mm. diam. near base.

Leaves about 12, the young $\pm$ ascending, $\pm$ recurved, the old ascending, long-recurved, $\pm$ tender, up to 5 cm. long, 9 mm. broad at base, $4\frac{1}{2}$ mm. thick near base, lanceolate acuminate, gradually tapering from near the base to the tip which bears a 2 mm. long naked, whitish, soon deciduous end-awn; *face* concave below, flat towards the middle, $\pm$ convex towards the tip, smooth, with 1—2 indistinct raised lines, dark dull green; *back* convex, smooth, very dark dull green; *margins* $\pm$ acute, with minute $\pm$ scattered whitish to concolorous teeth; *keel* 1, obliquely arranged in the upper half, with teeth like those on the margins.

Peduncle simple, terete, $\frac{3}{4}$ mm. diam., including the few flowered raceme up to 18 cm. long, rich dark brown towards the base; *raceme* about 3 cm. long, 6—8 spirally arranged flowers and buds, 1—2 open at a time; *pedicels* $1\frac{1}{2}$ mm. long, $\frac{3}{4}$ mm. diam., very dark brown; *sterile bracts* about 12, the lowest about 1 cm. from base of peduncle and about 6 mm. long including the long awn; *fertile bracts* 3 mm. long, ovate deltoid acuminate, white, with very fine light brown nerve; *perianth* white, 14 mm. long,

$2\frac{3}{4}$ mm. across the slightly enlarged triangular base, $2\frac{1}{4}$ mm. above, oblong, ascending, curved; *upper segments* obtuse, channelled, face colour of the 2 outer white, with a fine reddish-brown nerve, recurved, face colour of the inner segment white with a medium-fine green nerve, less recurved than the outer; *lower segments* obtuse, channelled, face colour of the 2 outer segments white at tip, pale green below, pinkish at base, with a medium-fine green nerve, recurved, face colour of the inner segment white, with a fine brown nerve, more recurved than the outer segments; *stamens* $4\frac{1}{2}$ and 4 mm. long; *ovary* $2\frac{1}{4}$ mm. long, 1 mm. diam., green; *style* $\frac{1}{2}$ mm. long, whitish, bent, capitate.

Habitat: Cape Province; Albany division. (Type, G. G. Smith 6819, in the East London Museum Herbarium.)

Distribution: not further known.

This variety is described from material collected by Prof. R. H. Compton in Jan., 1947, near Frasers Camp, in the Grahamstown district, some miles from the type locality of *H. angustifolia* var. *grandis* G. G. Smith, growing in grass veld in full sun. This new variety has fewer leaves than the species and the pedicels are much shorter. Compared with the var. *albanensis* (Schnl.) v.P. the pedicels are shorter and the leaves are more attenuate. It also differs from these two plants in that it is not, or is at the most only very slowly proliferous from the base.

Haworthia musculina, G. G. Smith. (Liliaceae-Aloineae.) Sect. Coarctatae.

Caulis foliatus longus una cum foliis circiter 20 cm., a basi proliferans.

Folia ascendunt, incurvata, longa 40 mm., lata 19 mm., ovata, lanceolata, acuta-acuminata; *supra* plana; *subtus* circiter 16 albis sublatiis tuberculis in lineis transversalibus ornatus.

Pedunculus simplex, diam. $1\frac{1}{4}$ mm., una cum racemo circiter 21 cm. longus; *pedicelli* longi $2\frac{1}{4}$ mm. diam. omnino 1 mm.; *perianthium* album, longum 16 mm.

Leafy stem up to 20 cm. long and 60 mm. diam. including the leaves, erect, becoming procumbent, proliferous from the base and forming large clusters, light green, becoming bronze in the sun.

Leaves multifarious, ascending, incurved, firm, coriaceous, 40 mm. long, 19 mm. broad above the base, $9\frac{1}{2}$ mm. thick below the middle, ovate-lanceolate, acute-acuminate, reddish brown cusp; *face* flat-convex, smooth, with a raised concolorous longitudinal middle line and one on each side arising from the margins about the middle of the leaf and meeting

the middle line at different points near the tip, pale green becoming reddish green in the sun; *back* rounded, beset with about 16 transverse rows of raised white round and mostly oblong (transversely oblong) $\frac{1}{2}$ — $\frac{3}{4}$ mm. diam. hardly prominent tubercles, a few confluent transversely, the rows at the middle of the leaf about $2\frac{1}{2}$ mm. apart; *keel* central or $\pm$ obliquely arranged in the upper $\frac{3}{4}$.

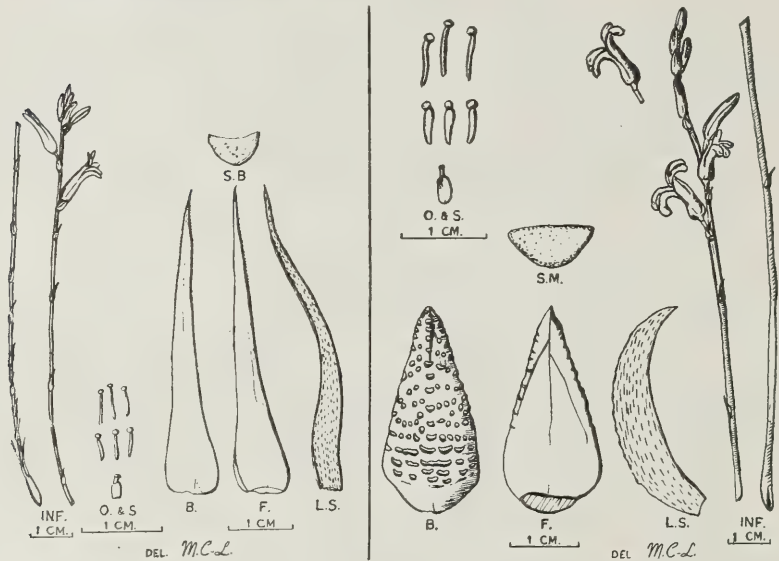


FIG. 3.

H. angustifolia var. *paucifolia*.*H. masculina*.

Peduncle simple, terete, $1\frac{1}{4}$ mm. diam., about 21 cm. long including the raceme, dark brown below; *raceme* sub-laxly flowered, about 10 spirally arranged flowers and buds, 1—2 open at a time; *pedicels* $2\frac{1}{4}$ mm. long, fully 1 mm. diam., light brown; *sterile bracts* 4, the lowest one 4 cm. from the base of the peduncle; *fertile bracts* 2 mm. long, deltoid acute, white with a broad dark brown nerve; *perianth* white, 16 mm. long, the cylindrical-hexagonal sub-globose shortly (1 mm.) stipitate base 4 mm. diam., slightly constricted above, oblong, erect-spreading, curved; *upper segments* obtuse, very slightly recurved; *lower segments* obtuse, the 2 outer replicate-channelled, recurved about 60 degrees, spreading, the inner segment channelled, shorter; *stamens* 7 and 6 mm. long; *ovary* 3 mm. long, barely 2 mm. diam., light yellowish green; *style* $1\frac{1}{4}$ mm. long, whitish, straight, hardly capitate.

Habitat: Cape Province; Bathurst Dist. (Type *G. G. Smith* 5118, in the East London Museum Herbarium.)

Distribution: not further known.

This new species was collected by the author in May, 1940, about 15 miles N.W. of Port Alfred in the Bathurst District. The relationship between *H. musculina* G. G. Smith and *H. reinwardtii* Haw. is a close one. The leaves of both species are tubercled and their general habit is quite similar, but in appearance the former plant is distinguished by its being more robust, its yellowish-green colour, the tubercles not as white and the leaves less lanceolate.

***Haworthia reinwardtii* var *tenuis*, G. G. Smith. (Liliaceae-Aloineae.)**

Sect. Coarctatae.

Caulis foliatus simplex, circiter 20 cm. longus, diam. una cum foliis 25 mm.

Folia crebra, ascendunt, incurvata, infra. 27 mm. longa, supra. 20 mm. longa, 11—12 mm. lata; *supra* tuberculis concoloribus in 5—7 lineis longitudinalibus; *subtus* tuberculis albis in lineis 12 transversalibus et circiter 14 longitudinalibus.

Pedunculus simplex, diam. 1 mm. una cum racemo longus 27 cm.; *racemus* 12 cm. longus; *pedicelli* longi 5 mm.; *perianthium* album, longum 17 mm.

Leafy stem simple (occasionally branched above), procumbent, about 20 cm. tall and about 25 mm. diam., including the leaves, proliferous from the base and forming large dense clusters.

Leaves crowded, multifarious, ascending, incurved, firm, the lower ones 27 mm. long, the upper 20 mm., 11—12 mm. broad towards the base, about 4 mm. thick, lanceolate, acute-acuminate, cuspidate; *face* concave, reddish-green, sparsely beset with small, round, solitary concolorous tubercles in the upper $\frac{2}{3}$, in 5—7 longitudinal converging rows; *back rounded*, with about 12 transverse and about 14 indistinct longitudinal rows of round and transversely oblong, white, $\frac{1}{2}$ mm. diam. tubercles, the transverse rows $1\frac{1}{2}$ —2 mm. apart at the middle of the leaf, keeled in the upper $\frac{1}{2}$, light green to dark reddish-green, not shining.

Peduncle simple, fully 1 mm. diam. near base, including the raceme 27 cm. long, dark reddish-brown below; *raceme* 12 cm. long, about 18 spirally-unilaterally arranged flowers and buds, 2 open simultaneously; *pedicels* 5 mm. long, barely 1 mm. diam., erect, light brown; *sterile bracts* 2—3, about 4 mm. long, the lowest one about 8 cm. from base of peduncle; *fertile bracts* 1 mm. long, deltoid acute, white, with a broad

reddish-brown nerve; *perianth* white, 17 mm. long, the cylindrical-hexagonal sub-globose base $3\frac{1}{2}$ mm. diam., stipitate, only slightly constricted above, oblong, erect, hardly curved; *upper segments* obtuse, channelled, face colour of the 2 outer segments white, with a broad nerve which is red at tip and green below, recurved about 45 degrees, face colour of the inner segments pink towards the tip, light green below, with a dark green broad nerve, not or hardly recurved; *lower segments* obtuse, face colour of the 2 outer segments white towards the tip, light green below, with a broad greenish-brown nerve, long recurved about 45 degrees, replicate, face colour of the inner segment white with a broad greenish-brown nerve, channelled, very recurved; *stamens* 5 and 6 mm. long; *ovary* $3\frac{1}{4}$ mm. long, $1\frac{1}{2}$ mm. diam., bright green; *style* 1 mm. long, straight or only slightly bent; *capsule* 13 mm. long, $3\frac{1}{2}$ mm. diam.

Habitat: Cape Province; Alexandria Dist. (Type *G. G. Smith*, 3420, in East London Museum Herb).

Distribution: not further known.

This variety is described from material collected by the author in July, 1940, near Alexandria, where it grows in large dense masses in grass-lands and on the outskirts of dense scrub-bush. It is distinguished from the species by its being much taller, and much smaller in diam., and by its rope-like appearance in its procumbent habit. The tubercles are not as white as those of the species.

Haworthia reinwardtii* var *diminuta, G. G. Smith. (Liliaceae-Aloineae.)

Sect. Coarctatae.

Caulis foliatus erectus, usque ad $5\frac{1}{2}$ cm. longus, diam. una cum foliis 30 mm.

Folia ascendentia, incurvata, longa 20 mm., 6 mm. lata, lanceolata, acuminata; *supra* paucis minimis albidis tuberculis in lineis 3 longitudinalibus; *subtus* majoribus albis tuberculis in lineas 5 longitudinalibus ordinatas, 12 transversales inordinatas instructis percurta.

Pedunculus simplex, diam. 1 mm., una cum racemo longus 25 cm.; *racemus* longus 9 cm.; *pedicelli* longi 3 mm., diam. 1 mm.; *perianthium* album, longum 15 mm., basi subglobosa $3\frac{1}{2}$ mm.

Leafy stem erect, up to $5\frac{1}{2}$ cm. tall, 30 mm. diam. including the leaves, proliferous from the base and forming clusters.

Leaves crowded, multifarious, ascending, incurved, 20 mm. long, 6 mm. broad at the base, 3 mm. thick towards the base, firm, lanceolate, acuminate, cuspidate; *face* convex, with a raised longitudinal line on which are

arranged a few very small round and transversely oblong whitish tubercles, and often with a row of similar tubercles on each side of the middle row ; *back* rounded, obtusely keeled, beset with 12 irregular transverse and 5 regular longitudinal rows of round and transversely oblong, solitary, small, prominent white tubercles, those on the keel more oblong and $1\frac{1}{2}$ mm. apart at the middle of the leaf.

Peduncle simple, fully 1 mm. diam., including the raceme 25 cm. long, brown below ; *raceme* 9 cm. long, about 20 spirally arranged flowers

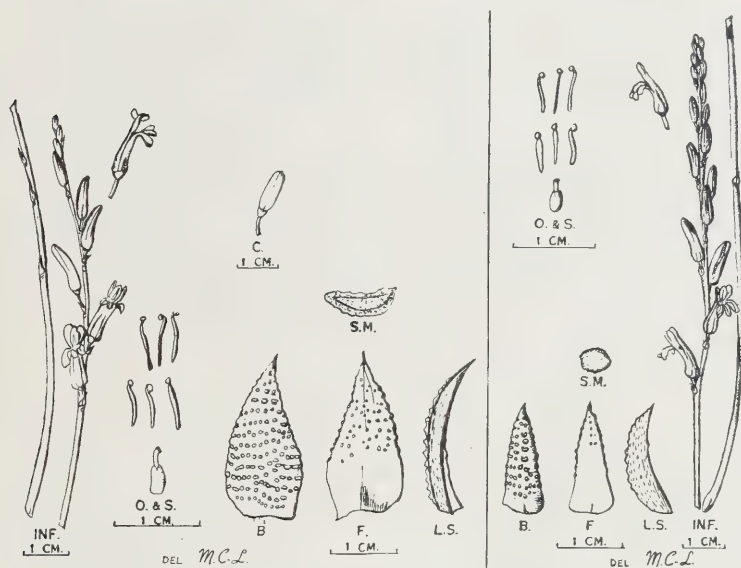


FIG. 4.

H. reinwardtii var. *tenuis*.

H. reinwardtii var. *diminuta*.

and buds, 2 open simultaneously ; *pedicels* 3 mm. long, fully 1 mm. diam., erect, greyish-green ; *sterile bracts* 2, 3 mm. long, the lower one $8\frac{1}{2}$ cm. from base of peduncle ; *fertile bracts* $2\frac{1}{2}$ mm. long, deltoid acuminate, white with a fine brown nerve ; *perianth* white, 15 mm. long, the cylindrical-hexagonal sub-globose base $3\frac{1}{2}$ mm. diam. (not stipitate), slightly constricted above, ascending, curved ; *upper segments* obtuse, channelled, $\pm$ recurved, face colour of the 2 outer segments white with a broad greenish-brown nerve, face colour of the inner segment white at tip, green below, with a broad nerve which is reddish at tip and darkish green below : *lower segments* obtuse, the 2 outer very recurved, spreading,

replicate, face colour pure white at tip, green below, with a broad greenish-brown nerve, the inner segment channelled, less recurved, shorter, face colour pinkish-white, with a broad reddish-brown nerve; *stamens* 5 and 6 mm. long; *ovary* $2\frac{1}{2}$ mm. long, $1\frac{1}{4}$ mm. diam., green; *style* $1\frac{1}{2}$ mm. long, greenish-white, with a white tip, straight, hardly capitate.

Habitat: Cape Province; Albany Dist. (Type, G. G. Smith 5177, in East London Museum Herb.)

Distribution: not further known.

This variety was collected by the Author in Sept. 1941, near Frasers Camp in the Albany district. As the name implies, this is a very small replica of *H. reinwardtii* Haw. Not only is the plant and its leaves smaller, but the tubercles are very much smaller, giving the plant a uniformly white-peppered appearance. *H. reinwardtii* v. *bellula* G. G. Smith is a smaller plant than this variety but is quite distinct.



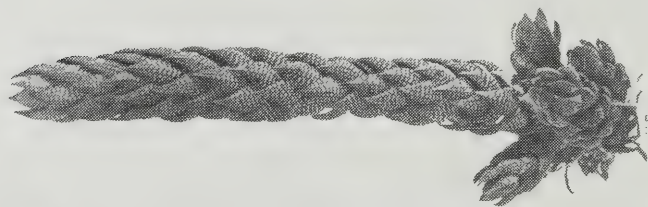
PLATE VII

H. reinwardtii var. *diminuta*.
H. atro-fusca.

H. viscosa var. *quaggaensis*.
H. heidelbergensis.



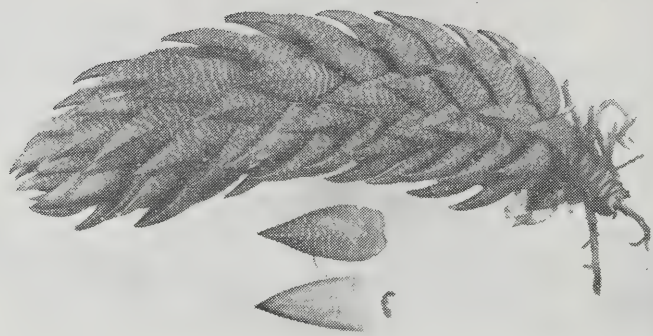
H. longiana
var. *albinota*.



H. reinwardtii
var. *tenuis*.



PLATE VIII.
H. angustifolia
var. *paucifolia*.



H. musculina.

VIEWS ON THE NAMING OF HAWORTHIAS.

(With Plate IX).

By G. G. SMITH,

(East London, South Africa.)

During the last 18 years or so, several botanists have from time to time published work on the Genus *Haworthia*. Without field experience of this very polymorphic genus, much of the work done has simply added to the already very confused position. To show the consequences of lack of field experience, I quote a few examples. In the *Cactus Journal*, Vol. 8 of 1939, on page 19, the late Dr. Karl von Poellnitz described a new species—*Haworthia Venteri*. According to the description, "the margins and keels of the leaf are mostly completely smooth, rarely with very few minute teeth-like tubercles seen only under a strong lens. Fig. 1 shows *H. Venteri* collected by myself from, according to Lt. Col. H. Venter, the type locality. It will be observed that while the plants are similar in size, and that the leaves are the same size, shape and colour, the one plant has a number of large (by no means minute) teeth on the margins and keel(s), while the other plant has leaves entire. The plants grow socially and flower at the same time, not only at the type locality, but also in several other localities in the Swellendam and Riversdale districts. When I mentioned that I had found the toothed and the entire leafed plants growing together, Lt. Col. Venter said he had noticed the two, but had not collected the toothed ones. It only remained for some other collector to send some of the toothed plants over, when we would have had another species or variety added to the already overburdened list of *Haworthia* names. At this stage I would mention the strange fact that the 4 new plants found by Lt. Col. Venter, are all recorded from the 4 districts—Worcester, Swellendam, Caledon and Bredasdorp.

On referring to the photo on page 18, and to the remark at the end of the description that "the innermost leaves of the plant shown in the photograph lengthened during the journey," one realises why it is impossible to determine so many *Haworthias* from descriptions and photographs by Dr. von Poellnitz.

Another example of describing and photographing a plant immediately after a long journey, is *H. paradoxa* v.P., in Fed. Rep. XXXIII (1933)

240. I have the original letter from Dr. von Poellnitz to Mrs. Ferguson of Riversdale, acknowledging the receipt of this plant. It reads as follows :— “ Dear Mrs. Ferguson, Indeed the *Haworthia* from Vermaaklikheid (Riversdale Div.), is a new species. I received it yesterday. I called it *Haworthia paradoxa* v.P. Today I sent the description to Professor Fedde, Dahlem, that he may print it.” Here we have an example of a plant arriving one day and the description and photograph being sent off the next day to the publishers. I defy anyone to determine *H. Venteri* from the description and photograph referred to above. Even if *Haworthias* have not had a long journey, it is never advisable to base descriptions or photographs on one or two plants ; it is also often necessary to make some field investigations before telling the world about it. Another similar example is in regard to *H. notabilis* v.P. This plant is described as having a completely smooth end-surface, only very seldom with a single pellucid tooth. I was taken to the type locality by Mr. Payne, the discoverer of this species, and there we found plants with completely smooth end-surface growing with plants identical in all respects, except that the end-surface was beset with many raised colourous toothed tubercles. See my fig. 2 and 3.

H. Parksiana v.P. is described in Fed. Rep. XLI (1937) 205, and the description concludes with the following statement :— “ Locality and discoverer unknown, Parks 636/32, Long—Port Elizabeth 352.” Major Long, at that time Director of *Parks and Gardens*, Port Elizabeth, had a private collection of *Haworthias* which he recorded under numbers preceded by his name, thus—“ Long-352 ”. The plants belonging to the Parks were similarly recorded thus—“ Parks-636/32 ”. In *Desert Plant Life* X (1938) 48, Dr. von Poellnitz concludes his description of *H. Parksiana* with the following words :— “ Type locality unknown This species is named in honour of *Mrs. Parks*, a keen collector of succulent plants ”. Dr. von Poellnitz certainly never got this information from Major Long, who was responsible for sending the plant, and the origin of “ *Mrs. Parks*, the keen collector of succulent plants,” is a mystery.

I have referred to only a few instances, and while they may sound amusing, they are, to say the least, very annoying, and show just how the confusion is brought about.

In the *Cactus Journal* VI (1938) 66-68, R. S. Farden publishes work on “ *H. attenuata*, its varieties and its near relations ”. Illustrations of leaves showing back and face of 11 varieties are given with a brief description of each. In Vol. VIII (1939) 34-38, he writes :— “ In the *Cactus Journal*, Vol. 6, No. 4, June 1939 (should be 1938) I published a series of varieties of *H. attenuata* Haw. Dr. von Poellnitz wrote me and said that it could not be accepted by botanists in that form, that of being

designated by letters, and would I repeat it in proper form, so I have done so and, in the interim, through searching in all sources, in Europe and S. Africa, I have got together others as well, as specified below." Then follow the illustrations of leaves (face and back) and brief descriptions of 19 varieties.

The claims made on the sizes and shapes of the leaves, and on the size and disposition of the tubercles, are, to say the least, absurd. In an area of about 200 by 50 yards on the slopes of the Fish River, in the Albany district, one can go on almost indefinitely picking out leaves with the differences on which Farden separates varieties. I would go so far as to say that on the basis on which Farden is working, there would be no difficulty in making two or more varieties of plants from the same clump. If one went further afield and included the many localities for *H. attenuata* and its varieties in the Grahamstown, Port Elizabeth, Uitenhage, Alice, King Williams Town and Peddie Districts, and worked on the basis on which Farden has done, we would end up with a fair sized volume devoted entirely to *H. attenuata* and its varieties. But what value would it have?

In *Suculentas Africanas*, Dr. Flavio Resende, himself and with collaborators, has from time to time published work on the Genus *Haworthia*. In Vol. XI (1942) 49-55, he and Dr. von Poellnitz published 7 new varieties of *H. tessellata*. Several of these are without precise locality, some having been found in gardens, others grown from seed, without locality. If this is all that is necessary, then instead of investigating plants in the field, it would be much easier to ask owners of succulent gardens to collect and send seed of their *Haworthias* and one would raise a wonderful collection of "species" and "varieties."

In Vol. II (1946) 175, Resende publishes a description of *H. lisbonensis*. He claims this to be a good species as it does not present forms of transition to any other species and that a study of the plants proved to him and J. Pinto-Lopes that they were dealing with a new species. This plant was found in the Botanical Gardens, Lisbon, and it is more than likely that it is a garden hybrid. In any case to call it *H. lisbonensis*, leads one to assume that it is indigenous to that area. I wonder what name he would give to a plant, probably a hybrid, found growing in a collection on a ship at sea.

On page 181, *H. Carrissoi* is described as a distinct species. This plant occurs in the same area as *H. glauca*, and according to Resende differs in the size of the leaves and the presence or absence of very small tubercles. This is certainly not sufficient difference to make this plant a variety, much less a species. It is common knowledge that the size of leaves in some species of *Haworthia* varies considerably, and some species in the Sect. *Coarctatae* are not exceptions. As regards tubercles, it is quite

common to find smooth and tubercled leaves on the same plant. In other cases plants of the same species or variety have smooth or tubercled leaves, for example, *H. fasciata* v. *variabilis* v.P. If one is going to "split" as is being done by Resende in the case of *H. Carrissoi*, then at the type locality of *H. fasciata* v. *variabilis* one can name probably a dozen species and varieties on the slight differences that are to be found among this lot of plants. *H. Carrissoi* is certainly not a species, nor even a good variety. It is at the most a locality form of *H. glauca*, and will have to be reduced to synonymy.

On page 188, Dr. Resende states :— "The fact of it (*H. Cassytha*) not flowering indicates its hybrid origin". Does this imply that *Haworthia* hybrids do not flower? I have many field and garden hybrids which flower and produce seed.

On page 191, in regard to *H. Greenii*, he writes :— "it appears at present that there are 3 forms, i.e. forma *Bakerii* (*Bakeri*), *minor* and *pseudo-coarctata*". The form *pseudo-coarctata* I note has had rather a gay life : first *H. Reinwardtii* var. *pseudo-coarctata* v.P., then *H. coarctata* v. *Haworthii* forma *pseudo-coarctata* (v.P.) Res., and now *H. Greenii* forma *pseudo-coarctata* Res. *H. Reinwardtii*, compared with *H. coarctata* and *H. Greenii* is a very distinct plant, and it puzzles me as to how the confusion could have taken place.

At Howiesons Poort, near Grahamstown, one finds *H. Greenii* and *H. coarctata* growing side by side, and surrounded by a mass of forms which include *Bakeri*, *minor* and *pseudo-coarctata*. (The latter, by the way, does not occur in the East London district, as recorded by Resende.) It would not be a difficult matter in this area to pick out, on the present basis of "splitting", at least another dozen or more forms. But where would it lead us to? He further states in regard to these 3 forms of *H. Greenii* :— "The characteristic which is specifically common to these three strains and which delimites them well from all other species of the same Section, is their light green colour, typical of this species". There are of course other plants of this colour, but not in any way connected with *H. Greenii* and its varieties; *H. Reinwardtii* v. *olivacea* G. G. Smith is one of them. This plant, like *H. Greenii* and its variety *silvicola* G. G. Smith, is olive green in colour. *H. Greenii* v. *silvicola* G. G. Smith occurs in the Bathurst Dist., some miles from Howiesons Poort, is quite a distinct variety, and is well isolated from other *Haworthias*.

In Vol. III (1943) 80, Dr. Resende writes :— "after having studied all the varieties which are today recognised in *H. Reinwardtii*, it is now not possible to maintain *H. Chalwinii* as a species". No definite reason is given why this plant is now reduced to a variety, yet some 2 years earlier he described *H. Carrissoi* as a species, and the only difference is

in the size of the leaves and the presence or absence of very small tubercles. It is very difficult to understand how, with such slight differences, *H. Carrossoi* is made a species, while *H. Chalwinii* is reduced to a variety of *H. Reinwardtii*, from which it differs so greatly in several details. In the same volume, page 93, 3 varieties of *H. limifolia* Marl. are briefly described, and the inflorescences of 2 of these are figured on page 92. The differences between the 3 varieties are in the size of the leaves, and in the length of the peduncle in relation to that of the raceme. The inflorescences of only *v. Schuldteana* and *v. Marlothiana* are figured, so I will deal with these 2 only. The comparisons from the descriptions and from the illustrations are absurd. In the case of the figure of the inflorescence of *v. Schuldteana*, the inflorescence is in its last stages, about 24 flowers having fallen, and only about 4 flowers and buds remaining at the apex of the raceme. It is claimed that the length of the raceme (including the portion where the flowers have fallen off) is longer than the peduncle, whereas in the inflorescence of *v. Marlothiana* (which inflorescence is quite new, no flowers having yet fallen), the raceme is shorter than the peduncle. It is evident that Dr. Resende is not aware of the fact that in the development of a *Haworthia* inflorescence, the peduncle, once the stage is reached where the first flowers commence to open, does not grow much longer, if at all, whereas the raceme continues lengthening until by the time nearly all the flowers have fallen, it may be anything up to twice as long as it was when the first flowers opened. Here again, as the leaves can vary considerably in the same plant, not much value can be attached to the differences mentioned. It would therefore seem, according to the basis on which Resende is working, that if one sees one of these 2 varieties with the raceme shorter than the peduncle, that is, at the stage of the inflorescence development when the first flower has just opened, it is var. *Marlothiana*, but a few weeks later, when practically all the flowers have fallen, and the raceme has become longer than the peduncle, it is then var. *Schuldteana*. Could anything be more ludicrous?

I have mentioned several instances of variable forms in *Haworthias*, and I feel that if the erection of "new species" and "new varieties" is to continue on such slight differences, the position in regard to this genus is going to be impossible. On krantzies around East London and other parts of the country, one finds *H. cymbiformis* or its varieties. On close examination, it will be noted that in an area of a square yard, they take on several different forms. There are the huge clusters made up of many large rosettes with broad, thick, entire leaves—the result of growing in a pocket of deep rich soil, and getting possibly only the morning sun. Then there are smaller clusters made up of very small compact rosettes with proportionately smaller leaves—growing in a pocket of shallow poor

soil and possibly in the full days' sun. Then there are the loosely arranged clusters, made up of rosettes with long, narrow, loosely arranged, toothed leaves—growing in full shade, usually in rich soil. Must these three forms be given distinctive names, simply because they look different. It reminds one of the incident when, at the request of an overseas enthusiast, a friend of mine sent him a small Aloe. Naturally, under overseas conditions, growing in a pot and receiving much more water than it was accustomed to in the dry South African conditions in which it occurs, it grew to about twice the size that it normally attains—it was described and published as a new species—yet the plant sent was a sucker from a named species.

On the hills overlooking the Fish River, at Kaffir Drift, there is an area of about 600 by 100 yards wherein *H. Reinwardtii* grows in great profusion. Here are found plants with tubercles arranged in longitudinal and/or transverse rows, the number of rows varying considerably, some plants with the tubercles round and/or oblong, some confluent longitudinally, others confluent transversely, plants with smooth leaf faces, others with faces tubercled in transverse or longitudinal rows, the number of rows varying, tall or short plants with long or short, broad or narrow leaves, dark green and yellowish green in colour—just a bewildering maze of confusion. I made a map of the area and collected, planted, and numbered about 30 different looking plants; the position of each being shown on the map. This was 8 years ago, and I am still studying the plants and the map. All these plants are growing under identical conditions—on a stony slope, facing N.W., in full sun. In the Steytlerville district one finds the same confusion with *H. Eilyae*, *H. Jonesiae* and *H. Jacobseniana*, etc. Include all the other areas where plants in the Sect. *Coarctatae* occur (and there are many of them), including Howiesons Poort, and the advocates of naming plants on trifling differences would have a very busy time.

My own view is that no new species or new varieties should be named where the only material available is one or two plants. Also it is most essential in all cases to study the plants in the field before an attempt is made at naming. In many cases, when plants have been sent to me, I have had to make certain investigations at the locality myself before describing them. Sometimes, even in the case of plants found by myself, it has been necessary to return to the locality to make further investigations. Many plants in the Genus *Haworthia* are sent to me from all over South Africa for determination, and I have frequently had to query the locality given. The following example will show why so many incorrect localities are quoted in some of the overseas descriptions—a collector labels a plant with a number and locality. In time, possibly

when the plants are neglected through pressure of other work, or through absence, the original plant dies and its place is taken by a seedling. This seedling, probably a hybrid, is sent away for determination and the locality recorded is that of the dead plant. Some collectors place all their plants loosely in a large carton and on their return from the trip sort out the plants to their respective localities—a most foolish practice. However, the plants are recorded under these localities. I have had *H. Reinwardtii* sent to me as from Riversdale district, and *H. retusa* from King Williams Town district, etc. etc., but my knowledge of the plants and their localities made me query the localities given, and no incorrect records were made.

Long and wide experience as a taxonomist has convinced me that in the genus *Haworthia* at best, opinions on systematics are likely to be of diminished value unless based partly on or correlated with the ecological aspect. My observations show that the work at long range of overseas taxonomists is hardly likely to afford any important aid in the solution of the many perplexing problems presented by this genus. When their descriptions are based on unnatural looking plants, and are accompanied by illustrations of poor quality, such work may indeed have to be ignored altogether.

The cited overseas methods of naming *Haworthias* (and some other genera) are merely reducing Taxonomy to a farce. Instead of contributing to the knowledge of *Haworthia*, such methods merely add to the existing confusion. The South African botanist finds it difficult enough to elucidate local problems, without having to cope with all the ridiculous nonsense published about them overseas. Some "Authors" will find the majority of their "species" in synonymy or ignored altogether, when the genus is monographed by one who knows what he is talking about. Overseas botanists would therefore be well advised to leave the describing of new species and varieties to some one in South Africa who knows the plants in their natural habitats, and knows how they vary in the wild state.

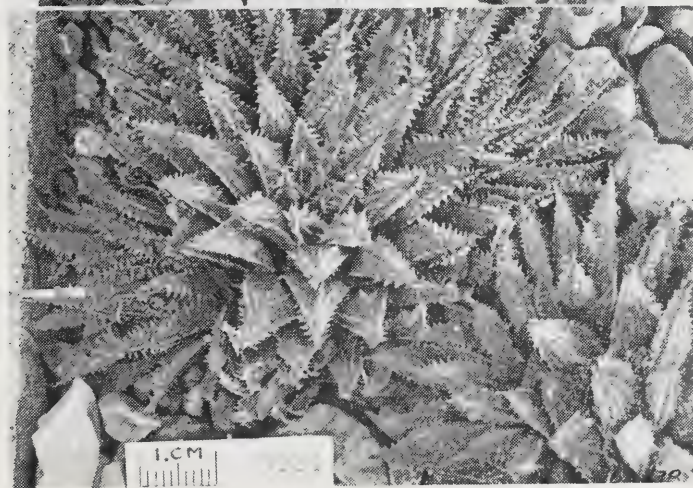
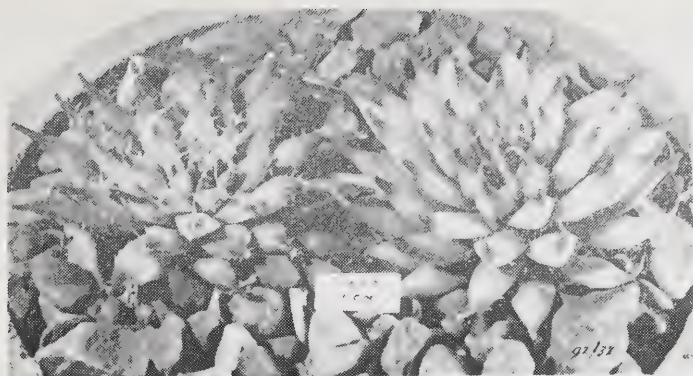


PLATE IX.

1. *H. Venteri* v. Poellnitz. Showing plants with toothed and entire leaves.
2. *H. notabilis* v. Poellnitz. Showing end-area of leaf smooth.
3. *H. notabilis*, showing end-area of leaf beset with toothed tubercles.

THE PARASITISM OF *ALECTRA VOGELII* BENTH. WITH SPECIAL REFERENCE TO THE GERMINATION OF ITS SEEDS.

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INTRODUCTION.

Although the root-parasites are well represented among the South African flowering plants, comparatively little is known about their life-histories, anatomy and ecology. The only species which has been studied fairly well, is *Striga lutea* Lour. (Witchweed). This semi-parasite causes serious damage to gramineous crops and is therefore of considerable economic importance. From the work of Pearson (1911, 1912 and 1913), Stephens (1912 *a* and *b*) and Saunders (1933) it is clear that its life-history quite closely resembles the life-cycles of the European semi-parasites.

Besides the witchweed, a few other South African root-parasites are of economic importance. This paper deals with one of these, viz. *Alectra vogelii* Benth., a semi-parasite which, though not so prevalent as *S. lutea*, is nevertheless a serious drawback to the cultivation of leguminous crops in certain areas of the Transvaal and Rhodesia.

In Dyer's "Flora Capensis" (Vol. IV, Sect. 2) (1904) Hiern does not retain the genus *Alectra* Thunb. (Benth. et Hook. f. Gen. Pl. ii, 996), but refers it to *Melasma* Berg. (Benth. et Hook. f. Gen., Pl. ii, 996). In the "Flora of Tropical Africa" (Vol. IV, Sect. 2) (1906) Hemsley and Skan are, however, of the opinion that it is better to follow Bentham in retaining both genera. They evidently attach considerable diagnostic importance to the fact that in *Melasma* the calyx becomes inflated in fruit, and use it to distinguish between the two genera. They also state: "The species of *Melasma* are not any of them root-parasites as far as we can tell."

A. vogelii is evidently of tropical origin, occurring at present in regions well north of the equator (Northern Nigeria) from which it extends to regions as far south as the Cape Province (Upington). Most of the specimens of this species in the South African herbaria have been collected in Southern Rhodesia (in the vicinity of Salisbury) and in the Northern

Transvaal. In the Western Transvaal the parasite occurs in the districts of Lichtenburg and Schweizer-Reneke. Most of the material for this investigation was collected at the Sannieshof School Farm (Dist. Lichtenburg), where the infestation is rather heavy at present.

THE LIFE-CYCLE AND ECONOMIC IMPORTANCE OF *A. vogelii*.

The life-cycle of the parasite is completed within a period of three to four months. When cowpeas are planted in January or February in infested soil, the first parasite plants appear about six weeks later. During the subterranean period the young plant lives holo-parasitically. With the appearance of the growing point of the stem above the soil surface, the plant enters the semi-parasitic stage of its life-history. The aerial parts become green and the parasite is able to synthesise its own organic foods, taking only water and mineral foods from the host plant. A few weeks after the appearance of the parasite, the first flowers open and within a period of about a month or six weeks later the first capsules are ripe. The seeds, which are extraordinarily minute, are produced in great profusion. They are, furthermore, especially adapted to wind dispersal by having loose, funnel-shaped testae which render them light so that they can be carried long distances. With the increasing cultivation of its host plants (leguminous crops) it can therefore be expected that this parasite may in the future become much more widely distributed than it is at present.

With regard to the damage caused by the parasite, it may be stated that it resembles *S. lutea*. The attacked host plants show unmistakable signs of wilting, even when the water content of the soil is still relatively high. Under conditions of drought the attacked plants wilt before those which are free from the parasite. The injury done to the host thus consists mainly in that the latter is robbed of its water supply. This may take place to such an extent that the host pines away and eventually dies. Like many other semi-parasites among the Scrophulariaceae, *A. vogelii* is therefore primarily a "water parasite". As the parasite has a very reduced root system, which is totally devoid of root hairs, it is, however, clear that there can be no appreciable absorption of inorganic nutrients directly from the soil and that these substances also have to be obtained from the host.

Other symptoms of the injury caused by the parasite are : the attacked plants are markedly smaller than those not attacked, they have a yellowish colour and produce practically no seeds. On heavily infested soil the crop is consequently very poor and not profitable.

The age at which the damage caused by the parasite becomes noticeable

in cowpeas varies with individual plants of the same variety. In some cases the different developmental stages of the parasite and host plant take place more or less simultaneously, whereas in others the host plant has already been killed and shrivels up before the parasite begins to flower. These differences are probably due to variations in the resistance of individual host plants towards the parasite, although other factors as, for example, the number of parasites per host plant and variations in the environmental conditions, may also play an important part.

THE GERMINATION OF THE SEEDS.

The seeds of some root-parasites germinate under more or less the same conditions as those of non-parasitic plants. Heinricher (1917), for instance, has found that the seeds of *Euphrasia* and *Alectorolophus* germinate readily under the usual conditions of moisture and temperature. In the case of many other root-parasites (semi-parasites as well as holoparasites), however, germination takes place only under the influence of a chemical stimulus, which has its origin in the roots of the host plant. This phenomenon was observed *inter alia* by Heinricher (loc. cit.) with *Tozzia* and *Lathraea*, by Garman (1903) with *Orobanche minor*, by Kusano (1908) with *Aeginetia indica*, by Saunders (loc. cit.) and Brown and Edwards (1944) with *Striga lutea*, and by Chabrolin (1937-1938) with *Orobanche speciosa*.

As far as Saunders (loc. cit.) could determine, the substance which is necessary for the germination of the seeds of *S. lutea* is exuded by the roots of species belonging to the Gramineae only. Thus there seems to be a very close relationship between the parasite and its host plants in this case: only the host plants exude the active substance and all of them are members of the Gramineae.

According to Chabrolin (loc. cit.) no such specific host-parasite relationship exists in the case of *Orobanche speciosa*. The active substance necessary for the germination of the seeds of this parasite, is exuded by several species, some of which are not naturally related to each other. The capacity of the roots to activate the germination and their capacity to nourish the parasite are two independent properties which co-exist in the habitual hosts only.

When the present investigation was started, the first problem was to determine to which of the above categories the seeds of *A. vogelii* belong. Are the seeds able to germinate independently of the host plants, and, if not, does there exist a specific relationship between the parasite and its hosts as far as the germination is concerned?

1. *Preliminary Experiments*.—Several attempts were made to germinate the seeds in the absence of any host factor. In each case the seeds were sown between two pieces of filter paper, then placed on fine river sand in a Petri dish, and moistened with tap water. The cultures were usually incubated at 30°C and daily examined under the microscope. Although some cultures were kept under these conditions for a month and longer, no germination was observed.

In the next experiment the possibility that the germination may be host-dependent was tested. The technique of Saunders (loc. cit.) for the germination of seeds of *S. lutea* was modified to suit the purpose. Seven cowpea seeds were planted in fine river sand in an earthenware pot with a pinch-cock outlet at the bottom. When the seedlings were about two weeks old an over-abundance of water was added to the pot. After 24 hours the excess was drawn off, and the "filtrate" obtained in this way was used in the germination tests. The Petri dish culture method was again adopted. One lot of seeds of the parasite was kept moist with the "cowpea filtrate"—fresh "filtrate" being added daily—while a second lot of seeds, which served as a control, was kept moist with tap water. Incubation took place at 30°C. Two days after the first treatment, it was observed that some of the seeds which had been moistened with the "cowpea filtrate", were already germinating. After a week the percentage germination in this dish had reached 47·5, whereas not a single germinated seed was observed in the control dish.

This experiment was repeated several times and the results obtained were similar. It is therefore clear that the roots of the cowpea plants exude a substance or substances (hereafter referred to as "active substance"), the presence of which is essential for the germination of the seeds of *A. vogelii*. After this fact had been definitely established, the question arose as to whether the roots of other species, host plants as well as non-hosts, also exude the active substance. This problem was not studied immediately, because it was thought necessary first to improve and to standardise the experimental technique.

2. *The Influence of Previous Exposure to Moist and Warm Conditions on the Germination of the Seeds*.—Certain observations which were made when endeavouring to induce germination in the absence of the host factor led to a considerable improvement in the experimental technique. In one of these experiments the seeds were kept moist at 30°C for two weeks, at the end of which period they still showed no signs of germination. They were then transferred to a Petri dish containing dry sand, a fresh "cowpea filtrate" was added, and incubation at 30°C was resumed. Though no further additions of "filtrate" followed, it was observed that two days later most of the seeds were germinating and on the fourth

day the percentage germination had reached about 80. This percentage was much higher than the values obtained by daily adding fresh "cowpea filtrate" to the seeds, as described above. If the fact is borne in mind that a single treatment of the dry seeds with "cowpea filtrate" causes no germination at all, this result becomes the more striking. The most obvious explanation of it is that the previous exposure of the seeds to the moist and warm conditions made them more sensitive towards the action of the stimulating substance. The next series of experiments was designed with the object of testing this probability more critically.

The essential feature of these experiments was that different lots of seeds were exposed for varying periods of time to moist conditions at 30°C, before aliquot portions of a "cowpea filtrate" were added. The Petri dish culture method was applied and the following quantities were used: about 300 seeds placed upon 100 gm. of sand were moistened with 25 ml. of tap water. After the period of exposure had elapsed, the filter papers with the seeds were transferred to Petri dishes containing 100 gm. of dry sand each, 25 ml. of the filtrate was added in each case, and the cultures were again incubated at 30°C. The possible influence of differences in the concentration of the active substance was eliminated by choosing the times when the imbibition was started in such a way that the periods of previous exposure to warm and moist conditions (hereafter termed "pre-exposure") elapsed simultaneously. The lots of seeds used in each experiment could consequently all be treated simultaneously with aliquot portions of the same "filtrate". The results of the first experiment are set forth in Table 1.

TABLE 1.

The Effect of Length of Previous Exposure to Moisture at 30°C on the Percentage Germination. (First Experiment).

Time of Pre-exposure in hours.	Percentage germination.
0	0
12	1.3
24	15.6
36	31.1
48	30.4

These results indicate an increase in the percentage germination when the period of pre-exposure is lengthened. As the percentage germination was, however, only about 30 with a pre-exposure of 48 hours, there was reason to believe that this period was still too short to obtain the maxi-

imum sensitivity of the seeds towards the active substance. In a second experiment, the results of which are recorded in Table 2, longer periods of pre-exposure were consequently applied.

TABLE 2.

The Effect of Length of Previous Exposure to Moist Conditions at 30°C on the Percentage Germination. (Second Experiment).

Time of Pre-exposure in days.	Percentage germination.
0	0
1	29·2
3	40·3
5	42·7
6	68·7
7	75·6
8	82·0
9	85·2
10	82·9

These results clearly suggest that the seeds are sensitised towards the active substance by pre-exposure. As the length of the pre-exposure increases, so does the percentage germination until an optimum exposure time is reached on about the eighth day. With pre-exposure periods of from 8 to 10 days the percentage germination remains more or less constant at a high level.

Another point of interest was what the effect of an unusual lengthening of the pre-exposure on the percentage germination would be. Under field conditions the seeds of the parasite are sometimes exposed for relatively long periods to a high soil moisture content and it is therefore of practical importance to know how such conditions affect the germination capacity.

To investigate this question an experiment was carried out in which the periods of pre-exposure varied from 14 to 40 days.

TABLE 3.

The Effect of Long Periods of Previous Exposure to Moisture at 30°C on the Percentage Germination.

Time of Pre-exposure in days.	Percentage germination.
14	98·6
20	94·6
30	86·0
40	84·3

The results, which are recorded in Table 3, indicate that when the seeds have once reached their maximum sensitivity towards the active substance, they evidently retain this sensitivity for at least another 30 days under moist and warm conditions.

The results of the last three experiments are in agreement with those obtained by Chabrolin (loc. cit.), but differ partly from those obtained by Brown and Edwards (loc. cit.). The former found that the seeds of *Orobanché speciosa* reached a maximum sensitivity towards the stimulating substance after having been pre-exposed to moist conditions for 15 days. After a month there were still no signs of secondary inhibition. Brown and Edwards (loc. cit.), working with the seeds of *Striga lutea*, also observed that pre-exposure enhanced the rate of germination. They, however, found that after the optimum time of pre-exposure had been reached, the germination capacity fell with a further prolongation of the period of pre-exposure. This difference between the results of Chabrolin and mine on the one hand, and those of Brown and Edwards on the other, may be due to differences among the root-parasites in this respect.

3. *The Technique applied in the Subsequent Germination Tests.*—After the fact had been established that exposure of the seeds to moist and warm conditions before the active substance is added, enhances the rate of germination, the procedure of pre-exposure was included in the further germination tests. The details of the method applied are the following: From 200 to 400 seeds are sown between two pieces of filter paper which are placed upon 100 gm. of fine sand in a Petri dish and moistened with tap water. The lid of the dish is replaced, and the culture is incubated for ten days at 30°C. During this period care is taken that the culture remains moist. The pieces of filter paper with the seeds are then transferred to another Petri dish containing 100 gm. of dry sand. 25 ml. of a "cowpea filtrate", which is obtained as already described, is immediately added. After another incubation period of 4 days at 30°C the percentage germination is determined with the aid of a binocular microscope.

As all the seeds cannot be brought into the field of the microscope simultaneously, they are counted as follows: the germinated seeds are first counted and removed with a double needle. Then a thin glass plate, ruled into small, numbered squares, is placed over the remaining seeds and the number in each square is determined. From these counts the percentage germination is calculated.

In general, good results were obtained with this technique. The germination was not only rapid, but also fairly uniform, as is indicated by the data presented in Table 4. These results were obtained by simul-

taneously doing twelve determinations on portions of the same seed sample. Aliquot portions of the same "cowpea filtrate" were used to supply the active substance in constant concentration. The value of the standard deviation calculated from these data is ± 3.2 .

TABLE 4.

Variation of the Percentage Germination as determined by the Method described in the Text.

No. of determination.	Percentage germination.
1	87.4
2	93.8
3	91.7
4	94.4
5	91.3
6	91.7
7	97.7
8	97.5
9	96.2
10	96.4
11	90.9
12	95.8

In the application of this technique during the rest of the investigation, certain modifications had sometimes to be introduced to suit the particular requirements of the experiments concerned.

4. *The Plant Species which exude the Active Substance.*—The next question to be investigated was whether the roots of plant species other than the cowpea also exude the active substance. The species which were tested included several leguminous plants as well as two non-leguminous species. In each case about seven seeds of the species to be tested were planted in an earthenware pot containing moist sand. When the plants were still young (from about two weeks to a month old) and growing vigorously a "filtrate" was obtained in the usual way. In some cases, where the seedlings were small and slender, for example *Sphenostylis angustifolia*, a culture solution was added to the sand in the pot. Only some weeks later, when the plants were growing healthily, the culture solution was drawn off and the sand in the pot was thoroughly rinsed with tap water, before an excess of water was added in order to prepare the "filtrate". In most cases, especially where the "filtrate" caused no germination, the tests were repeated several times. The results are presented in Table 5.

TABLE 5.

The Influence of "Filtrates" obtained from Cultures of Several Plant Species on the Germination of the Seeds of *A. vogelii*.

Name of Species.	Percentage germination.
Wild Cowpea (<i>Vigna sinensis</i>)	±80
Wild Vetch (<i>Vicia ervilla</i>)	±20
Spring Vetch (<i>Vicia sativa</i>)	± 5
Winter Vetch (<i>Vicia sativa</i>)	±10
Soybean (<i>Glycine hispida</i>)	Over 80
Ground-nut (<i>Arachis hypogaea</i>)	0
<i>Stizolobium deeringianum</i>	Over 80
<i>Dolichos donchos</i>	±80
Mung-bean (<i>Phaseolus aureus</i>)	Over 80
Sunnhemp (<i>Crotalaria juncea</i>)	0
Pigeon Pea (<i>Cajanus indicus</i>)	2
Sugar Bean	Over 80
Broad Bean (<i>Vicia faba</i>)	Over 80
Garden Pea (<i>Pisum sativum</i>)	0
<i>Sphenostylis angustifolia</i>	±10
Maize (<i>Zea mays</i>)	0
Sunflower (<i>Helianthus annuus</i>)	0

From these data it is clear that the "filtrates" obtained from the non-leguminous species (*Zea mays* and *Helianthus annuus*) did not cause germination, whereas nearly all the leguminous species activated the germination, the only exceptions being Sunnhemp, ground-nuts and the garden pea. The germination of the seeds of *Striga lutea* is activated by maize roots, and it is therefore clear that the substance necessary for the germination of the witchweed seeds is evidently not identical with that which activates the germination of the seeds of *A. vogelii*. It may be that the latter substance is exuded by the roots of leguminous species only, but more evidence is required on this point. The fact that the results were negative with three of the leguminous species, although the tests were repeated several times in each case, indicates that some members of the Papilionaceae apparently do not exude the active substance. It may, however, be that the roots of these plants exude the substance in such small quantities that it cannot be detected by the technique used in these experiments. That this may be the case is strongly suggested by the fact that I did not succeed in inducing germination with "filtrates" of ground-nuts, although some agriculturists assert that *A. vogelii* parasitises *Arachis hypogaea* in certain areas. The herbarium specimens of *Alectra* recorded as parasitising *Arachis hypogaea*, especially those of Galpin (8865 and 9046 both in Nat. Herb. Pretoria) and that of MacKay

(in Nat. Herb. Pretoria) were examined, and they were found to belong to *A. vogelii*. In view of these facts it was decided to attempt some other means of establishing whether or not the roots of ground-nuts are able to activate the germination of the seeds of *A. vogelii*. Several experiments were performed in which the roots of the ground-nut plants were brought into direct contact with the seeds of the parasite. This was done as follows: a piece of blotting paper was rolled cylindrically to fit the inside of a gas cylinder. The paper was moistened, and after the seeds were sown on its outer surface, it was pushed into the cylinder. A germinating seed of *Arachis hypogaea* was placed between the blotting paper and glass wall along the upper rim of the cylinder. The culture was kept moist by a small amount of water in the bottom of the cylinder. On the outside the cylinder was covered with dark paper and its mouth was plugged with cotton wool. The culture was kept at room temperature and was examined under the microscope at regular intervals.

As the taproot of the ground-nut seedling grew downwards, its branch-roots spread over the seeds of the parasite on the blotting paper, thereby coming into direct contact with many of them.

The results of the first experiments, which were carried out during the autumn under relatively cool conditions, proved to be negative. When they were repeated during the next summer, several of the seeds in contact with the host roots germinated. Although the percentage germination was low in all cases, it was high enough to exclude the possibility of independent germination (i.e., germination of a very low percentage of seeds of the parasite in the absence of the host factor) as exhibited by some parasites, e.g. *Striga lutea*. It was therefore concluded that the roots of ground-nuts also exude an active substance, though in very minute quantities. In fields infested with *A. vogelii*, where the roots of the ground-nut plants are able to come into direct contact with the seeds of the parasite, these small quantities of the exuded substance are evidently sufficient to cause a fair amount of germination.

Another point of interest in Table 5 is the fact that *Sphenostylis angustifolia* also caused germination of the seeds of the parasite. This leguminous species is indigenous to Southern Africa and occurs rather abundantly in certain localities in the vicinity of Potchefstroom. I have as yet not come across any evidence of *A. vogelii* occurring in the veld; in all cases that have come to my notice the parasite grew on cultivated leguminous crops. In a letter accompanying one of his specimens of *A. vogelii* to the Division of Botany and Plant Pathology, Pretoria, Galpin also wrote: "Though the neighbourhood was well collected over on many occasions, I never met with this species in the veld and do not know what its indigenous host plant is". As already mentioned, *A.*

vogelii is apparently of tropical origin. Some of its host plants, viz. certain cowpea varieties, are also indigenous to tropical Africa. The question now arises as to whether the parasite spread to the southern parts of Africa only after the cultivated host crops had been introduced into these parts, or whether the distribution of the parasite took place via uncultivated leguminous species which are indigenous to these southern parts. The fact that *Sphenostylis angustifolia* causes germination of the seeds of the parasite indicates that the second probability can not be dismissed, even though this species of *Alectra* has, to my knowledge, not yet been observed on uncultivated plants.

5. *The Influence of Various Concentrations of the Active Substance on the Germination.*—To determine the influence of various concentrations of the active substance on the germination, a "cowpea filtrate" obtained in the usual way, was used as initial solution. The concentration of the active substance in this "filtrate" was taken to be 100 arbitrary units. By diluting portions thereof with the appropriate amounts of tap water, solutions were obtained with concentrations of 5, 10, 25, and 50 arbitrary units. The activity of these solutions was tested in the usual way on sensitive seeds of the parasite.

The results, which are shown in Fig. 1, Curve A, clearly indicate that the concentration of the active substance has a pronounced effect on the percentage germination. With an increase in the concentration of the substance the percentage germination increases at a fairly rapid rate, until a concentration of about 25 per cent. of that of the mother solution used in this experiment is reached. With a further increase in the concentration the promoting effect becomes less pronounced. If it is taken into consideration that the total amount of substances exuded by the roots of the host plant is very small, and that the active substance probably constitutes only a small portion of this amount, it is clear that the concentration of this substance in the mother solution was very low. Nevertheless a solution having a concentration of only 5 per cent. of that of the mother solution caused germination of some of the seeds. It is therefore clear that the stimulating substance is biologically active even in extremely minute quantities.

A second experiment was carried out along similar lines, except that the active substance was applied in the form of an extract of cowpea roots. Five gm. of fresh cowpea root material with 100 ml. of distilled water was squashed in a mortar, and the mixture was filtered through dry cotton wool. The extract obtained in this way served as a mother solution, the concentration of which was again taken to be 100 arbitrary units. For the rest the procedure was the same as that of the previous experiment.

The results obtained agree quite closely with those of the last experiment, except that a more regular curve is obtained when they are represented graphically (Fig. 1, Curve B). From these data it is also clear that, if low concentrations of the active substance are applied, an increase in the concentration causes a greater increase in the germination percentage than when relatively high concentrations are applied. Furthermore, these results also indicate that the substance is active even in very low concentrations. When the sap of 5 gm. of root material was diluted with 2,000 ml. of water, the resulting solution still caused germination in about 16 per cent. of the seeds.

6. *The Influence of Temperature on the Active Substance.*—To get a better insight into the nature and physiological significance of the active substance, a study of its properties was undertaken. First of all its behaviour at various temperatures was investigated.

A fresh "cowpea filtrate" was obtained in the usual way and divided into aliquot portions. Each portion was quickly heated to the desired temperature, kept at this temperature for ten minutes and then cooled under running tap water. The influence of each of the following temperatures was studied: 30°C, 40°C, 50°C, 60°C, 70°C, 80°C, 90°C and 97°C (boiling point). Germination tests were then carried out with these pre-treated solutions.

TABLE 6.

The Effect of Temperature on the Stability of the Active Substance.

Temperature to which heated (°C).	Percentage germination.
30	76.2
40	75.3
50	78.2
60	65.6
70	54.2
80	29.5
90	10.4
97	0

The data recorded in Table 6 clearly indicate that the active substance is thermo-labile. Temperatures of 50°C and lower have no observable effect on the substance, but its activity is diminished by exposure to 60°C and higher temperatures. The higher the temperature, the more quickly the process of inactivation takes place. At boiling point the substance was completely inactivated within ten minutes.

In its thermo-lability the active substance resembles an enzyme. According to the present views on the nature and constitution of enzymes,

their thermo-lability is due to the fact that they are either proteins or proteids. It is, of course, possible that the active substance may be, like enzymes, of a proteinaceous nature without necessarily being an enzyme. Its thermo-lability may also be due to other causes. The substance may, for instance, be volatile and may therefore be expelled from solution at high temperatures.

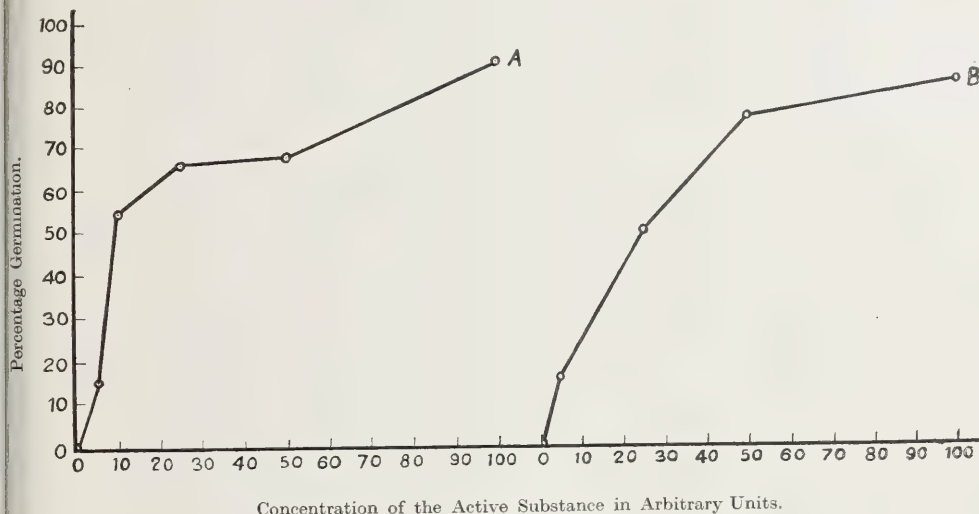


FIG 1.

The effect of different concentrations of the active substance on the germination of the seeds.

Curve A : seeds treated with "cowpea filtrate".

Curve B : seeds treated with cowpea root extract.

The instability of the substance at high temperatures is, in any case, a strong indication that it is not identical with the auxins (auxin *a* and *b*) which have been isolated from higher plants, for according to Went (1928), Boysen Jensen (1936) and others these auxins are heat-stable.

7. *The Effect of Ageing on the Stability of the Active Substance.*—

Having established the fact that the active substance is thermo-labile, the question arose as to whether it could retain its activity indefinitely at room temperature. Several experiments in this connection were carried out along the following lines : "Cowpea filtrates" containing the active substance were obtained in the usual way. 25 ml. of each "filtrate" was immediately added to sensitive seeds of the parasite. The rest of

the solution was kept in an unstoppered Erlenmeyer flask at room temperature. At varying time intervals portions of 25 ml. each were again removed to carry out germination tests. The seeds used in each test were taken from the same sample and had been previously sensitised in the usual way by incubation at 30°C under moist conditions for 10 days.

TABLE 7.

The Effect of Ageing on the Activity of "Cowpea Filtrates".
(*"Filtrates" stored at Room Temperature.*)

No. of Experiment.	Room Temperature (°C).	Age of "Filtrate" (Days).	Percentage Germination.
1	17—23	0	78·2
		2	34·9
		3	9·2
2	17—23	0	69·1
		2	3·6
		4	0
3	17—27	0	77·4
		2	35·5
		4	7·2
4	14—19	0	79·8
		2	87·7
		4	17·7
		7	1·4
5	13—19	0	78·4
		3	61·3
		7	3·0

From the results recorded in Table 7 it is clear that the active substance does not retain its activity when stored at room temperature. The rate at which the inactivation took place, was not the same in all the experiments. Whereas in some cases the "filtrate" was totally inactive after four days (Experiment 2), in other cases it still caused germination of some seeds after an ageing period of 7 days. (Experiments 4 and 5.) At low room temperatures the inactivation process evidently takes place at a slower rate than at higher temperatures. The length of the period in which the "filtrate" becomes totally inactive apparently also depends upon the initial concentration of the active substance.

The instability of the active substance at room temperature may be due to several causes, the most important being :

- (1) The substance may be volatile and may consequently escape from solution even at room temperature.

- (2) The substance may be oxidised by the oxygen of the air.
- (3) The substance may be sensitive to light and, as the "filtrates" used in the above experiments were exposed to daylight during the period of ageing, inactivation might have been caused by the light.
- (4) The substance may be decomposed by micro-organisms which may be present in the "filtrates".
- (5) The substance may undergo chemical changes such as decomposition, isomerisation, or denaturation. That such changes may occur in activation substances ("Wirkstoffe") obtained from plants, was demonstrated by several investigators. Kögl and his co-workers (Kögl, Koningsberger and Erxleben, 1936; and Koningsberger, 1936), for instance, have found that pure auxin becomes physiologically inactive within a few months even when sealed *in vacuo* and stored in the dark. The molecular weight remaining the same, this change is, according to them, due to isomerisation.

8. *Conclusion.*—The germination of the seeds of *A. vogelii* agrees in many respects with that of other root-parasites, e.g., *Striga lutea* and *Orobanche speciosa*. In general, the germination process can be divided into two phases, viz.: a first phase during which the seeds are sensitised under the influence of moist and warm conditions and a second phase which is initiated by the influence of an active substance exuded by the roots of the host plant and during which the primary rootlet starts growing.

Working on the seeds of *S. lutea*, Brown and Edwards (1944) describe the pre-exposure of the seeds to moist and warm conditions under the term "pretreatment." According to them the effects of pretreatment indicate that the host factor operates only at a comparatively late stage in the germination process. They maintain that certain developmental changes must occur in the seeds before the active substance can have any effect. These changes occur comparatively slowly, whereas those induced by the host factor are extremely rapid. They are, furthermore, of the opinion that pretreatment does not involve the acceleration of after-ripening, but simply promotes changes that belong to the germination process as such. In a later publication (1946) they put forward the tentative hypothesis that during pretreatment the seed itself forms a stimulating substance, which is the same as or similar to, that which originates in the host root.

The results obtained during the present investigation agree rather closely with those of Brown and Edwards, thereby indicating that in general there is great similarity between *A. vogelii* and *S. lutea* as far as

the germination is concerned. I feel inclined to agree with their conclusions in connection with the first phase of germination ("pretreatment"), but have to stress the fact that the present information bearing on this problem is still rather scanty. Before any definite conclusions can be arrived at our knowledge has to be supplemented by further investigation.

Furthermore, with regard to the nature of the active substance and its mode of action we still know very little. Perhaps some of the data on the germination of the seeds of the orchids with endotrophic mycorrhiza indicate the way for further investigation of this problem. Burgeff (1936) and afterwards his student, Schaffstein (1938), found that in the orchid genera, *Phalaenopsis* and *Euanthe*, the embryo suffers an avitaminosis, the mycorrhizal fungus supplying it with the missing factor necessary for germination. Furthermore, the living fungus can be replaced with an extract from it. Of still more importance is the fact that activation can also be effected by extracts of yeast or of wheat germ. These findings indicate that the relationship between the orchid and the symbiotic fungus is not as specific as was formerly believed. In the case of the angiospermous root-parasites with host-dependent germination, the relationship between the embryo of the parasite and the root of the host may be much the same. No definite conclusions can, however, be arrived at before more is known about the properties and physiological significance of the substances necessary for the germination of the seeds of various root-parasites. In a subsequent paper I hope to report on further investigation which is now being carried out in this direction.

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I wish to express my sincere gratitude to Prof. Dr. A. P. Goossens, head of the Department of Botany of the Potchefstroom University College for the keen interest he has taken in this work, and to Mr. G. F. Combrink, principal of the Sannieshof School Farm and Junior High School, for supplying the seed material used in this investigation.

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SUMMARY.

1. A short account is given of the life-history and economic importance of *A. vogelii*.

2. The roots of the host plants of the parasite exude a substance which is necessary for the germination of the seeds of the parasite.

3. Exposure of the seeds of the parasite to moist and warm conditions, before the active substance is added, enhances the rate of germination. When such pre-exposure forms part of the germination technique, fairly constant results are obtained.

4. Nearly all the leguminous species tested, exude an active substance, whereas the non-leguminous species did not activate the germination.

5. Although the stimulating substance is active even in very minute quantities, its concentration has, within certain limits, a pronounced effect on the germination.

6. The active substance is thermo-labile. When "cowpea filtrates" are exposed to temperatures of 60°C and higher they become less active. At boiling point such a filtrate is totally inactivated within 10 minutes.

7. When aged at room temperature in unstoppered flasks the active substance also becomes less active. Under these conditions total inactivation of a "cowpea filtrate" takes place within from 4 to 8 days.

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SOME CHANGES IN NOMENCLATURE—V

By MISS F. M. LEIGHTON, MRS. M. R. LEVYNS and MISS G. J. LEWIS.

I. By MISS F. M. LEIGHTON.

Carpolyza tenella (L.f.) Leighton.

Crinum tenellum L.f. Suppl. Pl. p. 194 (1781); Jacq. Ic. II t. 363 (1786—93).

Haemanthus spiralis Ait. Hort. Kew. ed. I. vol. 1, p. 405 (1789).

Carpolyza spiralis Salisb. Parad. Lond. t. 63 (1806); Salisb. Gen. 119 (1866); Herb. Amaryll. 292, t. 29, fig. 9 (1837); Bak. Fl. Cap. VI, p. 192 (1896).

Hessea spiralis Berg. in Linnaea I, p. 252 (1826).

Strumaria spiralis Ait. Hort. Kew. ed. II, vol. 2, p. 213 (1811).

Amaryllis spiralis L'Hér. Sert. Angl. 10, t. 13 (1788).

It is necessary to change the name of the genus *Hessea* of Herbert (Amaryll. 1837) since Bergius (in Linnaea I, p. 252, 1826) had previously used the name *Hessea* for the genus *Carpolyza*, so that *Hessea* Herb. is invalid. It appears that the first valid name for this genus is *Periphanes* Salisb. (Gen. p. 118, 1866) which was given to the species known as *Hessea crispa* and *Hessea stellaris*.

Periphanes stellaris Salisb. Gen. p. 118 (1866).

Amaryllis stellaris Jacq. Hort. Schoenbr. I, t. 37 (1797); Willd. Sp. Pl. II, p. 61 (1800); Ait. Hort. Kew. ed. II, vol. 2, p. 229 (1811).

Strumaria stellaris Gawl. Bot. Mag. sub t. 1363 (1811).

Hessea stellaris Herb. Amaryll. p. 289 (1837); Kunth Enum. V. p. 630 (1850); Bak. Fl. Cap. VI p. 189 (1896).

Periphanes cinnamomea (L'Hér.) Leighton.

Periphanes crispa Salisb. Gen. p. 118 (1866).

Amaryllis cinnamomea L'Hér. Sert. Angl. p. 16, t. 17 (1788).

Hessea cinnamomea (L'Hér.) Dur. & Schinz Consp. Fl. Afr. p. 242 (1895).

Hessea crispa Kunth Enum. V, p. 632 (1850) ; Bak. Fl. Cap. VI, p. 190 (1896).

Amaryllis crispa Jacq. Hort. Schoenbr. I, t. 72 (1797).

Strumaria crispa Gawl. Bot. Mag. t. 1363 (1811).

Periphanes dregeana (Kunth) Leighton.

Hessea dregeana Kunth Enum. V, p. 633 (1850) ; Bak. Fl. Cap. VI, p. 190 (1896).

Periphanes Zeyheri (Bak.) Leighton.

Hessea Zeyheri, Bak. Handb. Amaryll. p. 22 (1888) ; Bak. Fl. Cap. VI, p. 191 (1896) ; Fl. Pl. S. Afr. t. 43 (1922).

Periphanes brachyscypha (Bak.) Leighton.

Hessea brachyscypha Bak. Fl. Cap. VI, p. 191 (1896).

Hessea bachmanniana Schinz in Bull. Herb. Boiss. IV, p. 812 (1896).

Periphanes spiralis (Bak.) Leighton.

Hessea spiralis Bak. Handb. Amaryll. p. 22 (1888) ; Bak. Fl. Cap. VI, p. 191 (1896).

Periphanes Leipoldtii (L. Bolus) Leighton.

Hessea Leipoldtii L. Bolus in S.A. Gard. XX, p. 148 (May, 1930).

Periphanes gemmata (Ker) Leighton.

Strumaria gemmata Ker Bot. Mag. t. 1620 (1814).

Hessea gemmata B. & H. Gen. Pl. III, p. 721 (1883).

Imhofia gemmata Herb. Amaryll. p. 291 (1837) ; Kunth Enum. V, p. 627 (1850).

Imhofia burchelliana Herb. Amaryll. p. 290 (1837) ; Kunth Enum. V, p. 628 (1850).

Hessea burchelliana B. & H. Gen. Pl. III, p. 721 (1883).

Periphanes karooica (Barker) Leighton.

Hessea karooica Barker in Journ. S. A. Bot. vol. I, p. 32 (1935).

Periphanes unguiculata (Barker) Leighton.

Hessea unguiculata Barker in Journ. S. A. Bot. vol. I, p. 33 (1935).

Periphanes strumosa (Ait.) Leighton.

Leucojum strumosum Ait. Hort. Kew. ed. I, vol. I, p. 407, t.s. (1789); Jacq. Ic. II, t. 361 (1786—93); Thunb. Prod. p. 58 (1794).

Strumaria filifolia Edwards Bot. Reg. t. 440 (1820).

Strumaria strumosa Salisb. Gen. p. 127 (1866).

Imhofia filifolia Herb. Amaryll. p. 290 (1837); Kunth Enum. V, p. 625 (1850).

Hessea filifolia B. & H. Gen. Pl. III, p. 721 (1883).

Until further work is done to ascertain the exact manner of attachment of the anthers to the filaments this species has been placed with the other members of the former genus *Hessea*. It might, however, prove to be a *Strumaria*.

It is doubtful from the description whether *Hessea Schlechteri* O. K. (Rev. Gen. III. 2. p. 310, 1898) is not a *Nerine*, and it has accordingly been excluded from the above list until material is available for examination.

Albuca canadensis (L.) Leighton.

Albuca major L. Sp. Pl. ed. II, p. 438 (1762).

Albuca minor L. *ibid.*

Ornithogalum canadense L. Sp. Pl. ed. I, p. 308 (1753).

Linnaeus followed Cornut who had erroneously ascribed this South African plant to Canada.

Brunsvigia orientalis (L.) Ait. ex Eckl. Top. Verz. p. 7 (1827).

Amaryllis orientalis L. Sp. Pl. p. 293 (1753).

Brunsvigia gigantea Heister Monog. (1753).

Brunsvigia multiflora Ait. Hort. Kew. ed. II, vol. II, p. 230 (1811).

Ecklon in his *Topographisches Verzeichniss* p. 7 makes the combination *Brunsvigia orientalis* for the first time though he ascribes it to Aiton. Possibly he had seen a manuscript name on a plant named by Aiton. He attributes the genus to Ker, probably from the article under t. 923 in the Bot. Mag. In the second edition of the *Hortus Kewensis* Aiton gives the specific epithet *multiflora* in transferring the plant from *Amaryllis* to *Brunsvigia*. In the second edition of the *Species Plantarum* Linnaeus cites Heister's *Brunsvigia* as a synonym of *Amaryllis orientalis*.

II. By MRS. M. R. LEVYNS.

EROEDA Levyns nom. nov.

The name *Oedera* which was established by Linnaeus (Mant. II, p. 159, 1771) for a genus of *Compositae*, is antedated by *Oedera* Crantz

(De duab. Dracon. arb. p. 13, 1768), a genus belonging to Liliaceae. R. Mansfeld drew attention to this (Kew Bull. 1935, p. 441) and stated that a new name ought to be found for the Linnaean genus. The anagram *Eroeda* is proposed. This change of name necessitates several new combinations as follows: ***Eroeda hirta*** (Thunb.) Levyns comb. nov.; ***Eroeda imbricata*** (Lam.) Levyns comb. nov. (= *Oedera latifolia* Less); ***Eroeda intermedia*** (DC) Levyns comb. nov.; ***Eroeda capensis*** (L.) Levyns comb. nov. (= *Oedera prolifera* L.); ***Eroeda laevis*** (DC.) Levyns comb. nov.; ***Eroeda Muirii*** (C. A. Smith) Levyns comb. nov.

Scirpus Leptus (C.B.Cl.) Levyns comb. nov.

This species was described by Clarke as *Eleocharis Lepta*. However, it lacks the characteristic swollen style base of *Eleocharis*. The type specimen (Wolley Dod 3541) is young and there are no fruits. Three minute perianth bristles are present but similar bristles are found in many species of *Scirpus*. The species is closely related to *Scirpus delicatulus* Levyns from which it differs in its lack of leaf blades and in its perianth bristles.

Felicia amoena (Sch. Bip.) Levyns comb. nov.

This species may be distinguished from *F. Pappi* (Harv.) Bolus and Wolley Dod by its slightly fleshy, almost glabrous, linear-spathulate leaves and by a tendency for the lower decumbent branches to root at the nodes. It was first described as *Agathaea amoena*, based on a specimen collected by Krauss on the sandy shore at Hout Bay. This species is locally common at Hout Bay to-day and seems sufficiently distinct from *F. Pappi* to warrant retention.

Diplopappus fruticosus (L.) Levyns. nov. comb.

Aster exilis Ell., a recent introduction from America, is spreading rapidly as a weed on the Cape Peninsula. The inclusion of this plant as a constituent of the flora of the Cape Peninsula necessitates a change of name for a native plant, *Aster fruticosus* L., which clearly does not belong to the same genus. It is therefore proposed to adopt the generic name *Diplopappus*, used by Harvey in the Flora Capensis, for the plant hitherto known as *Aster fruticosus*. Harvey unfortunately used the combination *Diplopappus fruticosus* Less. As the original name of the species was *Aster fruticosus* L., it is necessary to make a new combination, *Diplopappus fruticosus*.

Chironia decumbens Levyns nom. nov.

Chironia maritima Eckl. is antedated by *Chironia maritima* Willd., a

name given to a non-African plant. As *Chironia maritima* Eckl. has no valid name, *Chironia decumbens* is proposed for it.

Microdon capitatus (Berg) Levyns comb. nov.

This species has hitherto been known as *Microdon ovatus* Choisy, based on *Lippia ovata* L. (Mant. I, p. 89). *Selago capitata* Berg was an earlier name for the same plant.

III. By Miss G. J. LEWIS.

Herschelia lacera (Swartz) Lewis comb. nov.

Disa lacera Swartz in Vet. Acad. Handl. Stockh. (1800), 212; Thunb., Fl. Cap. ed. Schult., 12; Lindl., Gen. & Sp. Orch., 354; Drege, Zwei Pfl. Documente, 122; Sond., in Linnaea xix, 97; Journ. Hort. (1888), ii, 220, fig. 24; N.E. Br., in Gard. Chron. (1888), iv, 664; Bolus, in Journ. Linn. Soc., xxv, 202; Ic. Orch. Austr.-Afr., iii, t. 52; Dur. & Sch., Conspect. Fl. Afr., v, 103; Kranzl. Orch. Gen. et Sp., i, 797, partly; Schlechter in Engl. Jahrb., xxxi, 287. *D. lacera* var. *multifida* N.E. Br., in Gard. Chron. (1888), iv, 664, fig. 93; Bot. Mag. t. 7066. *D. barbata* Lindl., Gen. & Sp. Orch., 354, partly, not of Sw. *D. venusta* Bolus, in Journ. Linn. Soc. xx, 482; Trans. S. Afr. Phil. Soc. v, 170, t. 9; N.E. Br., in Gard. Chron. (1885), xxiv, 232; Dur. & Sch., Conspect. Fl. Afr. v, 110. *Herschelia venusta* Kranzl., Orch. Gen. et Sp. i, 805 (1900); Rolfe, in Fl. Cap. v, 202.

Gladiolus monticolus Lewis nom. nov.

I propose this name for the small *Gladiolus*, endemic on Table Mt., for many years known as *G. tabularis* Eckl. (Top. Verz. 38 (1827)). Unfortunately Ecklon's name is not valid as it is antedated by *G. tabularis* Pers. (Syn. i, 44 (1805)). *G. tabularis* of Persoon is *Exochebea parviflora* (Jacq.) Foster (Contr. from Gray Herb. of Harvard Univ. cxxvii, 38 (1939)).

Dr. N. E. Brown, in his notes on the South African Iridaceae of Thunberg's herbarium (Journ. Linn. Soc. xlviii, 54 (1928)), made the following comment on *Moraea umbellata* Thunb.: "Two sheets: (a) is *Moraea umbellata* Thunb. The type specimen of the species. It is the same plant as Zeyher 4087 and is distinct from *M. edulis* Ker. (b) This is not the same as *M. umbellata* Thunb. nor is it *M. edulis* Ker as named by Klatt. It is the same as a specimen at Kew collected by Wallich."

A specimen of Zeyher 4087 from the South African Museum herbarium was compared with the type of *Homeria bobartioides* L. Bolus at the Bolus Herbarium and found to be the same. There is no doubt that

this plant is a *Homeria* and not a *Moraea* and that Thunberg's specific epithet, being the earliest, should be retained. I therefore propose the following combination :—

Homeria umbellata (Thunb.) Lewis comb. nov.

Moraea umbellata Thunb. Diss Mor. 13 (1787) ; Diss. no. 16 ; Prodr. 11 ; Fl. Cap. i, 279 ; *M. fasciculata* Soland MSS. ; *M. edulis* Ker var. *umbellata* (Thunb.) Baker Fl. Cap. vi, 21 ; *Bobartia umbellata* Ker Gen. Irid. 31 ; *Aristea umbellata* Spreng. Syst. Veg. i, 158 ; *Homeria bobartioides* L. Bolus Journ. Bot. lxix (1931) 12.

This species appears to have a fairly wide range of distribution. It has been recorded from the Piquetberg, Malmesbury, Stellenbosch, Worcester, Robertson and Caledon Districts.

There is considerable confusion about the identity of *Moraea aristata* (Houtt.) Asch. & Graebn., and the various views concerning this plant are given in the following notes. Two species have been confused under this name and these require renaming as the combination itself is not valid. As Houttuyn's figure and description are not available in this country and have not been seen, it is not possible to arrive at a certain conclusion. Also it has not been possible to examine the older specimens in herbaria overseas.

The combination as published is as follows :—

Moraea aristata Asch. & Graeb. Syn. Mitteleurop. Fl. iii, 518 (1905—07). *Vieusseuxia aristata* Houtt. Handl. xii, 105, t. 80 (1780). *Iris tricuspidata* L.f. Suppl. 98 (1781). *Iris tricuspis* Jacq. Ic. ii, t. 222 (left fig.) (1786—93). *Moraea tricuspis* Ker Bot. Mag. t. 696 (1803). *Vieusseuxia tricuspis* Spreng. Syst. Veg. i, 165 (1825).

In making this combination Ascherson and Graebner have obviously overlooked the earlier use of the name *aristata* by De la Roche (1766) and have taken the plant figured and described by Houttuyn to be the same as both *Iris tricuspidata* L.f. and *Moraea tricuspis* Ker. var. A. In 1928, in his notes on the Iridaceae of Thunberg's herbarium (Journ. Linn. Soc. xlviii, 39) Dr. N. E. Brown adopted Ascherson and Graebner's combination but applied it to the plant hitherto known as *Moraea glaucopsis*. He retained as a synonym *Iris tricuspidata* L.f. and added *Moraea glaucopsis* Drap. but excluded *Moraea tricuspis* Ker which he rightly regarded as a separate species. The following are his comments :—

“*I. tricuspis* Thunb. Diss. Iris, 14 (1782). Five sheets :—

1 and 2. *Moraea aristata* Aschers & Graebn. Synop. Mitteleurop. Fl. iii, 518 (1906). *Vieusseuxia aristata* Houtt. Handl. xii, 92, t. 80, f. 1 (1780) ; *Iris tricuspidata* Linn. f. (1781) ; *Vieusseuxia glaucopsis* DC. (1803) ; *Moraea glaucopsis* Drap. (1836).

Although the figures in Houttuyn's 'Handleiding' are usually fairly good, the colouration of them is execrable and very misleading unless the description is consulted. The flower in the figure quoted is coloured uniformly pale and dingy yellow, but is correctly described as white, with a purple spot at the base of the limb of the outer perianth-segments; otherwise the figure clearly represents the plant known as *Moraea glaucopis*, and agrees with the type of *Iris tricuspidata* Linn. f., of which there is an authentic specimen in the Smith Herbarium, received from Thunberg in 1791. It is not the same plant as that figured in the Bot. Mag. at t. 696 as *Moraea tricuspis* var. a, nor is Thunberg's plant *Vieusseuxia villosa* Spreng., as named by Klatt on the sheet.

3 seems different from the plant on sheets 1 and 2, and Klatt may be right in naming it *Vieusseuxia Bellendeni* Sweet.

4 is *Moraea villosa* Ker.

5 contains two species, which I have marked A and B :—

A is probably *Moraea tricuspis* Ker, as to Bot. Mag. t. 696. It is not *M. aristata* Aschers. & Graebn.

B is a species of *Moraea*, which is the same as Burchell 6386, placed under *M. polyanthos* Thunb. by Baker. Neither specimen is *Homeria miniata* as named by Klatt."

So far this appears satisfactory except that the species known as *Moraea tricuspis* Ker (based on *Iris tricuspis* Thunb.) is left without a name, but a year later, in his notes on the Iridaceae of Burmann's Fl. Cap. Prodr. (Kew Bull. 1929, 138), N. E. Brown made the following remarks :—

"*Vieusseuxia aristata* Burm. not of La Roche. The herbarium contains three sheets so named. The principal one, and probably that intended to bear the name = *Moraea villosa* Ker, and from this specimen the figure in Houttuyn Handleid. xii, t. 80, f. 1, named *V. aristata* was evidently drawn; but this specimen is certainly *M. villosa*, and has pubescent leaves and purplish flowers."

From this it is clear that Burmann's specimen is *M. villosa*, but if it is the plant figured by Houttuyn, as N. E. Brown suggests, then it would seem that *V. aristata* Houtt. must be the same as *Moraea villosa* and not *M. glaucopis* which is a different species. N. E. Brown made no reference to his earlier work and the position as regards the identity of Houttuyn's plant is therefore very difficult.

There seem to be two possible interpretations of N. E. Brown's position. (1) That his later work supersedes the earlier and that he means to imply that his first identification of *Iris tricuspidata* L.f. and

Moraea glaucopsis Drap. with Houttuyn's figure was not accurate. (2) That his earlier identification is to stand and that both these are *Moraea villosa*. Bearing in mind all Dr. Brown's remarks, this latter interpretation is extremely unlikely. If one accepts the view that Houttuyn's figure was drawn from a specimen of *M. villosa* then his name must apply to that species. The following extract from Dr. Brown's notes on Burmann's Iridaceae (Kew Bull. 1929, 129) adds some weight to this view :—

"The collection is an interesting one ; the specimens are mostly very good and well preserved. Many of them are from cultivated plants, and some, I find, are the actual specimens from which the figures in Houtt. Handl. Plant. en Kru. Vol. xii, were drawn. These figures, on account of their worthless colouration, have by many been considered to be poor or bad figures ; but so far as these specimens show, in outline and size they are exceedingly accurate, so that a photograph would scarcely give the outline more exactly. The names, however, under which they are figured, require to be investigated before accepting them as authentic."

It remains now to show why Houttuyn's use of the name *aristata* was invalid. In 1766 De la Roche (Descr. 1, 31—34) described three species of *Vieusseuxia*, namely (1) *V. spiralis* ; (2) *V. fugax* ; (3) *V. aristata*. The first, *V. spiralis* De la R., is now *Moraea Bellendeni* N.E. Br. (Kew Bull. 1929, 139). The two others, however, have been the cause of some confusion due to the fact, as pointed out by Ker, that there is very little doubt that De la Roche mixed up their specific names, as the following extracts from his descriptions clearly indicate :—

(2) *V. fugax* De la R. "... Petalorum vero interiorum trium, lacinae mediae *aristatae*, rectae . . ."

(3) *V. aristata* De la R. "... Flores lutei *fugaces* vix per trihorium persistentes . . ."

Ker went so far as to change these two specific names around, and in Bot. Mag. under t. 696 he placed *V. glaucopsis* DC. and *V. aristata* De la R. as synonyms under *Moraea tricuspis* var. B., with the following note about the latter : "quo male invicem commutantur nomina trivialia duarum ultimarum specierum ; postremae ergo penultima redonetur titulus, et vice versa." In Bot. Mag. t. 1238, Ker placed *V. fugax* De la R. as a synonym under *Moraea edulis* Ker var. Roem. & Schult., in Syst. Veg. i, 489—490 (1817) followed Ker in changing De la Roche's specific names around.

Even though the names were confused, they have to remain in the order in which they were published. Baker, in his work on the Iridaceae in the Fl. Cap. (vi, 21) placed *V. aristata* De la R. as a synonym under *Moraea edulis* Ker var. *longifolia*. According to De la Roche's description there is no doubt that it is the same as this plant. The name *aristata*

should, by rights, have been given to the species, but since it has been used, although incorrectly, for another species in the genus, it cannot now be restored to this species.

With regard to *Viusseuxia fugax* De la R., Baker did not consider this to be the same as *Moraea glaucopis* Drap. and, as the name *fugax* had already been used in the genus *Moraea* (*M. fugax* Jacq. Hort. Vind. iii, 14, t. 20 (1776) = *M. edulis* Ker), he renamed this species *Moraea candida* Baker and added a note to the effect that it was known only from De la Roche's description. From the description it is clearly the same as *M. glaucopis*.

Whether *V. aristata* Houtt. is the same as *Moraea villosa* or *M. glaucopis*, it is certainly not the same as *Viusseuxia aristata* De la Roche, and Ascherson and Graebner's combination therefore falls away and cannot be applied to *Moraea glaucopis* Drap. nor to *M. tricuspis* Ker. For the former the earliest name is *Viusseuxia fugax* De la R. but previous use of the name *fugax* in the genus *Moraea* precludes its use for this species. As it is the same as *Iris tricuspidata* L.f. I propose the following new combination with synonymy :—

***Moraea tricuspidata* Lewis comb. nov.**

Iris tricuspidata L.f. Suppl. 98 (1781) ; *Iris tricuspis* Thunb. Diss. Iris 14 (1782), partly ; Jacq. Collect. iv, 99, t. 9, f. 1 (1790) ; *Viusseuxia glaucopis* DC. Ann. Mus. ii, 141, t. 42 (1803) ; Red. Lil. t. 42 (1802) ; Flore des Serres, t. 423 ; Baker in Journ. Linn. Soc. xvi, 133 (1878) ; Klatt Erganz. 34 ; *Moraea glaucopis* Drap. Enc. iv (1836) cum ic. ; Baker Handbk. Irid. 59 (1892) ; Fl. Cap. vi, 23 ; *Viusseuxia fugax* De la R. Deser. 33 (1766) ; DC. in Ann. Mus. ii, 139 ; *Moraea candida* Baker Handbk. Irid. 59 ; Fl. Cap. vi, 24 ; *Iris Pavonia* Curt. Bot. Mag. t. 168 (1791) non aliorum ; *Moraea tricuspis* Ker var. B, Bot. Mag. sub t. 696 (1803).

As there is no name available for *Moraea tricuspis* Ker var. A this species will have to be given a name. I therefore propose the following :—

***Moraea confusa* Lewis nom. nov.**

Moraea tricuspis Ker var. A., Bot. Mag. t. 696 (1803) ; Gen. Irid. 36, in part ; Baker, Handbk. Irid. 58 (1892) ; Fl. Cap. vi, 25 ; *Iris tricuspis* Thunb. Diss. Iris 14 (1782), in part ; Jacq. Ic. ii, t. 222, left fig. (1786—93) ; *Viusseuxia tricuspis* Spreng. Syst. Veg. i, 165 ; Baker in Journ. Linn. Soc. xvi, 133 (1878) ; Klatt, Erganz. 34 (1882).

CORRECTION.—In describing *Romulea longituba* as a new species (Journ. S.A. Bot. VII, p. 43) I overlooked the fact that this species had already been described by Dr. L. Bolus. The correct naming is therefore *R. longituba* L. Bolus.

A FIRST REPORT ON MYCORRHIZA ASSOCIATED WITH SOME TRANSVAAL PLANTS.

By C. COHEN.

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(With Plate X.)

Mycorrhizal association with a variety of plants in different families, in varying ecological situations, has been widely reported from all over the world, but no systematic investigation has been reported from this country.

Particular interest in the occurrence of mycorrhizas in the Transvaal was stimulated by reports of their presence in the roots of local grasses and herbs (1, 4). The writer, however, has not been able to find a fungus of the mycorrhizal type in any of the plants mentioned by these authors which he checked. Undoubtedly, examination of apparently quite normal roots will often show the presence of fungal threads, but as indicated below, microtomed sections with careful techniques are recommended, whereas Page and Coetzee report a wealth of detail from hand-cut sections stained with cotton blue.

The following methods were examined for the testing of fresh material :—

Staining with Pianese 3B, differentiating with acid alcohol, and clearing with benzene phenol.

Margolena's modification of Stoughton's method, using 0.1% thionin in 5% aq. phenol, counterstaining with 0.5% light green in alcohol, and Orange G and erythrosin in clove oil.

Staining with 0.1 g. Ruthenium red in 15 cc. distilled water, differentiating in KOH.

Iron haematoxylin counterstained with erythrosin.

Mordanting an entire root in 2% iron alum, staining in haematoxylin, differentiating in acid alcohol, and counterstaining with Orange G.

Clearing in lactophenol, staining in cotton blue in lactic acid, and differentiating in lactic acid.

While the first, second, and last methods were good, it was soon obvious that hand sectioning was unsatisfactory for mycorrhizal examination, and was often extremely difficult, for anatomical reasons, with some grasses.

The following combinations of fixatives and stains were then tried on microtomed material, with every possible pairing :—

- Fixatives.* Helly fluid ; formalin-aceto-alcohol ; chromacetic, weak and strong ; Carnoy's ; Flemmings ; 5% chromic sulphate in saturated picric or salicylic acids (2).
Stains. Iron haematoxylin with fuchsin iodine ; Ikata's method (3) ; iron haematoxylin with Pianese 3B ; safranin and fast green or a triple combination ; Benda's haematoxylin ; Margolena's method ; Pianese 3B ; lactophenol and cotton blue ; Conant and Johansen's quadruple stains (3).

Helly fluid with Conant's quadruple stain was finally selected, and the following method employed :—

Material was fixed overnight in Helly fluid, made as below :—

Distilled water, 100 cc. ; Mercuric chloride 5 g. ; Potassium dichromate, 2.5 g. ; Sodium sulphate, 1 g. To 20 cc. of this fluid, 1 cc. of neutralized 40% formalin was added immediately before use.

The material was then washed in water, and the mercury removed before cutting by $\frac{1}{2}$ % iodine in 70% alcohol. The iodine was removed by washing the material with 70% alcohol, followed by 5% sodium thio-sulphate, which was then removed by washing with water.

The material was next passed through 30% and 50% ethyl alcohol, and through the following mixtures, each of these steps lasting about two hours :—

Distilled water, 50 cc. ; 95% ethyl alcohol, 40 cc. ; butyl alcohol, 10 cc.
 Distilled water, 30 cc. ; 95% ethyl alcohol, 50 cc. ; butyl alcohol, 20 cc.
 Distilled water, 15 cc. ; 95% ethyl alcohol, 50 cc. ; butyl alcohol, 35 cc.
 95% ethyl alcohol, 45 cc. ; butyl alcohol, 55 cc. ; butyl alcohol, 75 cc.
 absolute ethyl alcohol, 25 cc.

The material was thereafter passed through three changes of pure butyl alcohol, the second or third being overnight, and then left for two or more hours in a mixture of butyl alcohol and paraffin oil. It was then passed through two changes of Parowax, and finally embedded in 52—54° C. paraffin wax.

The blocks were poured, cooled in water, and kept until used in a refrigerator.

Before cutting, the face of the block was exposed with a sharp razor, and the block was soaked in iced distilled water for 1—2, or 12, or a maximum of 24 hours.

Sections were cut at between 8—10, and up to 30 μ .

Haupt's adhesive, made as follows, was used for fixing sections, to slides :—

1 g. of pure, plain gelatin was dissolved in 100 cc. distilled water at 30° C. When completely dissolved, 2 g. phenol crystals were added and 15 cc. glycerine. In very cold weather, it was advisable to keep the adhesive in an incubator at below 30° C. ready for use.

The sections were floated on a bath of 4% formalin, which helped to stretch them, and then lifted from the bath on a prepared slide. They were allowed to dry, without further draining. If the sections were very thick, it was necessary to keep the slides constantly exposed to formalin vapour for up to six hours, at room temperature, to harden the adhesive.

When the sections and slides were completely dry, they were passed through pure xylol, then a mixture of absolute alcohol and xylol, in each case, for 5 minutes. They were then left in 95% ethyl alcohol, and 70% alcohol, for 2 minutes. They were then stained for 2 hours or more in 1% safranin in 50% alcohol. The sections were then washed in water, stained in 1% aq. crystal violet for about a minute, washed in water and two changes of absolute alcohol, before being stained for 1 minute in 0.1% alcoholic Fast Green FCF. This was followed by three transfers through Orange G in clove oil, and a wash in xylol, before being mounted in Clarite.

Polypodiaceae.

Pteridium aquilinum. Negative.

Commelinaceae.

Cyanotis nodiflora. Negative.

Gramineae.

Andropogon appendiculatus. Negative.

Aristida junciformis. Negative.

Avena sativa. Negative.

Brachiaria serrata. Negative.

Eragrostis capensis. Negative.

Eragrostis chloromelas. Negative.

Eragrostis nebulosa. Negative.

Helictotrichon cf. turgidulum. Negative.

Hordeum vulgare. Negative.

Hyparrhenia hirta. Negative.

Lolium perenne. Probable, tiller leaves; negative, roots, stems and upper leaves.

Rhynchelytrum repens. Negative.

Secale cereale. Negative.

Tristachya hispida. Negative.

Triticum sativum. Negative.

Zea Mays. Negative.

Liliaceae.

Aloe transvaalensis. Negative.

Amarantaceae.

Alternanthera repens. Negative.

Gomphrena globosa. Pelotons.

Casuarinaceae.

Casuarina Cunninghamiana. Negative. Pericarp wing and seed coat.

Compositae.

Berkheya speciosa. Pelotons.

Berkheya subulata. Negative.

Bidens Schimperii. Negative.

Conyza ambigua. Arbuscule-sporangiole.
Conyza ivaefolia. Negative.
Cosmos bipinnata. Negative.
Dicoma Zeyheri. Arbuscule-sporangiole.
Geigeria Burkei. Negative.
Galinsoga parviflora. Arbuscule-sporangiole.
Haplocarpha scaposa. Arbuscule-sporangiole.
Helichrysum cf. leiopodium. Negative.
Helichrysum Cooperi. Arbuscule-sporangiole.
Inula graveolens. Arbuscule-sporangiole.
Nidorella hottentotica. Pelotons.
Nidorella polycephala. Pelotons.
Schukhria bonariensis. Negative.
Senecio coronatus. Negative.
Senecio fraudulentus. Pelotons.
Senecio glandulifera. Pelotons.
Senecio hydrorhizus. Arbuscule-sporangiole.
Senecio isatideus. Negative.
Senecio laevigatus. Negative.
Senecio serratuloides. Negative.
Senecio succosus. Negative.
Senecio venosus. Negative.
Tagetes minuta. Negative.
Ursinia annua. Negative.
Vernonia Kraussii. Negative.
Xanthium pungens. Negative.
Xanthium spinosum. Arbuscule-sporangiole.

Cruciferae.

Brassica rapa. Negative.
Lepidium bonariensis. Negative.
Nasturtium officinale. Negative.

Dipsaceae.

Scabiosa anthemifolia. Pelotons.

Euphorbiaceae.

Acalypha caperonoides. Negative.
Euphorbia platyphylla. Negative.

Loganiaceae.

Gomphostigma virgata. Negative.

Leguminosae.

Cassia minosoides. Negative.
Medicago sativa. Negative.
Robinia pseud-acacia. Negative.
Sphenostylis angustifolia. Negative.
Trifolium repens. Negative.
Vicia sativa. Negative.
Vigna vexillata. Negative.

Malvaceae.

Hibiscus malacospermus. Negative.
Hibiscus trionum. Arbuscule-sporangiole.

Polygonaceae.

Polygonum glutinosum var. *capense*. Negative.

Rosaceae.

Prunus persica. Negative.

Rhamnaceae.

Zizyphus mucronata. Negative.

Solanaceae.

- Datura stramonium*. Arbuscule-sporangiole.
- Physalis minima*. Negative.
- Solanum capense*. Negative.
- Solanum panduriforme*. Negative.
- Solanum tuberosum*. Negative.

Tropaeolaceae.

- Tropaeolum majus*. Negative.

Umbelliferae.

- Daucus carota*. Negative.

Verbenaceae.

- Verbena bonariensis*. Negative.
- Verbena erinoides*. Negative.

DISCUSSION AND SUMMARY.

The number of families, genera or species examined was not large in number, so that it is difficult to draw definite conclusions from the finding that 18 out of 82 species contained a fungus of the mycorrhizal type. Moreover, with the exception of some maize plants, and the single example of a fern, all the plants examined came from the Witwatersrand area, that is, from a sandy soil of granite origin.

The two morphological types were not confined to any family or genus, nor were they seen together, in any plant.

Only one member of the Gramineae, of those examined, showed a mycorrhiza.

Mycorrhizas were not confined to perennial plants.

No mycorrhiza was found in any crop plant, although such cases have been reported from overseas.

A relatively large proportion of those "weeds" examined showed a mycorrhiza.

ACKNOWLEDGMENTS.

My best thanks are due to Prof. J. F. V. Phillips, in whose department this work was done, for suggesting the subject to me, and for his interest since; and to Mr. S. W. Adamson, who, by collecting the plants for examination, made the work possible.

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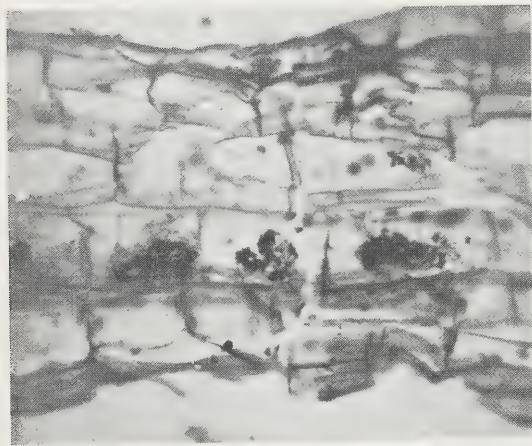
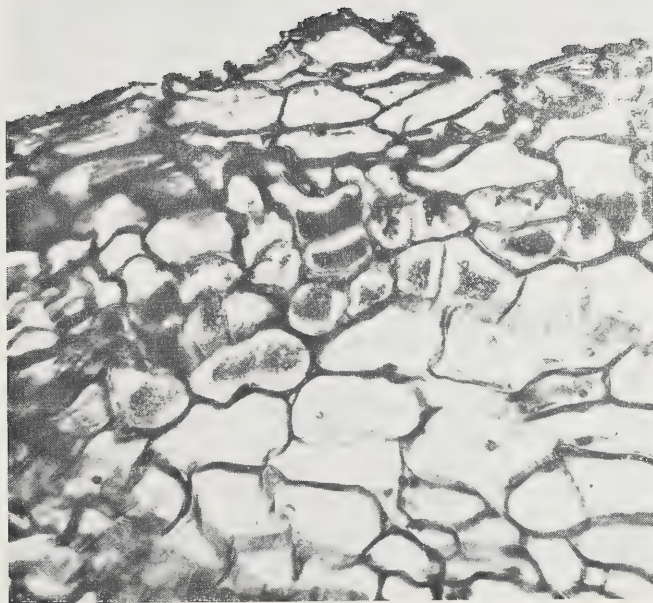


PLATE X. Mycorrhiza.

(From slides cut at 10 mu, and stained with Conant's Safranin-Crystal Violet-Fast Green-Orange G combination.)

1. L. S. root of *Coniiza ambigua*, showing arbuscule-sporangioles. In this type, a branching structure, at this stage, bears densely staining organs, which are apparently in a process of digestion and disintegration. Sometimes, therefore, only the branching is seen, if the process has gone far. The arbuscule-sporangiole is always seen within the cell, and in this case stains densely blue-violet. It tends to lie in the cortical regions nearer the endodermis. $\times 185$.

2. T. S. Root of *Gomphrena globosa*, showing the skeins called pelotons, which stain reddish purple. They are found in the cortical regions, and the outermost tend to show digestion. $\times 185$.

CHROMOSOMES IN A TRIPLOID GASTERIA.

(With Plate XI.)

By HERBERT PARKES RILEY.

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In most plants which have been studied in the genus *Gasteria* the haploid chromosome complement consists in four long and three short chromosomes. Three of the long chromosomes have subterminal centromeres and the fourth has its centromere farther removed from the end. The three short chromosomes have subterminal centromeres. This chromosome complement has been reported for eleven species and varieties by Ferguson (1926), for two species and some unidentified plants by Taylor (1924, 1931) and Tuan (1931), for twelve species by Marshak (1934), for fifteen species and varieties by Sato (1937), and for seventeen species and three unidentified plants by Resende (1937). In a preliminary report on the genus, the writer (Riley, 1945) has listed eleven species and varieties as well as five putative inter-specific hybrids as having the same complement.

A few plants of *Gasteria* with more than eight long and six short chromosomes have been recorded. Miss Ferguson has reported that one plant, *G. nigricans crassifolia*, was a probable tetraploid since it had twice as many long chromosomes as are found in most plants, but she was unable to obtain an exact count of the small chromosomes. Sato has reported a tetraploid plant of *G. maculata* which had 16 long and 12 short chromosomes in the somatic cells. Apparently no triploids have been found in *Gasteria* except one mentioned by the writer in his preliminary report, although Resende (1937) found three triploid plants of *Apicra bicarinata* which, he believes, were the only triploids found in the *Aloinae* up to that time.

Chromosome behaviour has been studied in a number of organisms that possess both large and small chromosomes. In some, chiasma frequency is proportional to chromosome length for all chromosomes and the small chromosomes sometimes fail to pair; in others the small chromosomes always pair. O'Mara (1931) found the latter situation in *Yucca flaccida*. This plant has five long and twenty-five short chromosomes. The long ones are 3μ long and have an average chiasma frequency

of three. The short chromosomes are only 0.4μ long but are all paired although a high percentage of univalents would be expected if chiasma frequency were strictly proportional to the length of the chromosomes. Figures illustrating a similar complete pairing of the small chromosomes of *Yucca filamentosa* and *Agave virginica* have been published by McKelvey and Sax (1933). Some other organisms in which pairing is not directly proportional have been listed by Darlington (1937). Apparently chiasma frequency is not directly proportional to length in organisms with localised pairing and in many that have general pairing if the short chromosomes are one-fourth the length of the long ones or are relatively shorter and if the short chromosomes are part of the normal chromosomal complement.

MATERIALS AND METHODS.

The plant discussed in this paper was one of a collection of succulents belonging to Professor Frank T. McFarland of the University of Kentucky. It was received in 1938 from the Huntington Botanical Gardens in California under the name *Gasteria sulcata* $\times$ *G. nigricans*.

Although this plant was labelled a hybrid, it more nearly resembles Baker's (1897) description of *G. nigricans*. The leafy stem is larger and the leaves more numerous than in *sulcata*. The leaves are generally shorter than those of *sulcata* and are dark green with a glossy surface like those of *nigricans*. The bracts also resemble those of *nigricans*. In the Flora Capensis the leaves of *sulcata* are described as being distichous or in a slightly twisted rosette and those of *nigricans* as distichous. The triploid resembles *sulcata* in this respect but is even more twisted (Plate XI). The leaves of the triploid appear to be thicker than those described in the Flora Capensis for either species or than the leaves on the specimens of *G. nigricans* or *G. sulcata* which we have available. This greater thickness, however, may merely be a reflection of the triploid nature of the plant. Berger (1908) describes the perigonium of *sulcata* as 25 mm. long and that of *nigricans* as 18 to 20 mm. The triploid was intermediate, having a perigonium 22 mm. in length.

All slides were prepared from fresh anthers by the original acetocarmine smear technique of Belling (1921). Examinations were carried out with a 2 mm., $90\times$ Bausch and Lomb apochromatic objective, N.A. 1.30, and a $15\times$ compensating ocular. Drawings were made with a camera lucida at a magnification of about $2850\times$ at drawing-board level and were subsequently reduced.

OBSERVATIONS.

Taylor (1931) has shown that the chromosomes of a diploid *Gasteria* line up on the metaphase plate of the first meiotic division with the three

pairs of small chromosomes at the centre of the figure and the four large bivalents radiating outward. At first anaphase one large bivalent usually separates slightly before the others.

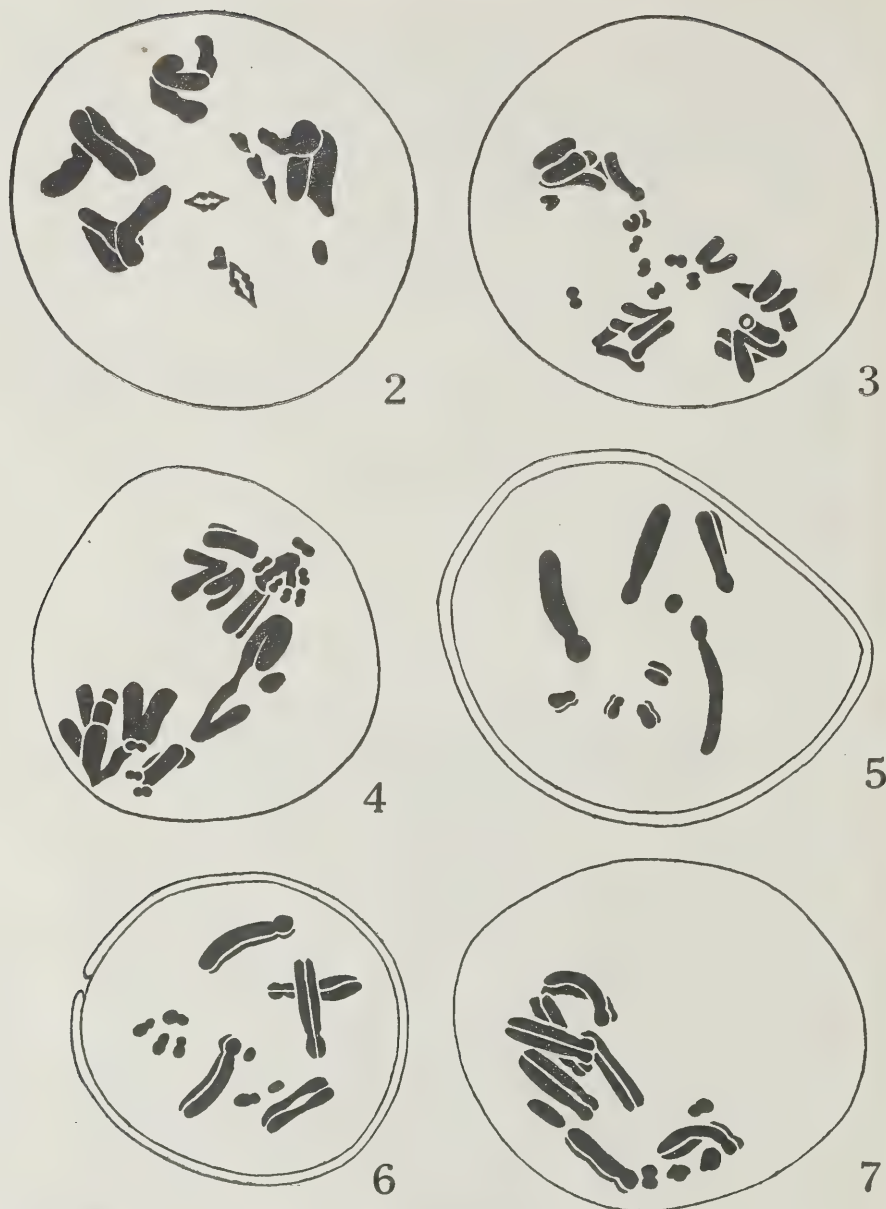
TABLE 1.

The frequency of Microsporocytes with Varying Numbers of Quadrivalent (IV), Trivalent (III), Bivalent (II), and Univalent (I) Configurations in a Triploid Gasteria.

Large Chromosomes.					Small Chromosomes.			
IV.	III.	II.	I.	Freq.	III.	II.	I.	Freq.
1	1	2	1	2	2	1	1	1
0	4	0	0	93	1	2	2	3
0	3	1	1	21	1	1	4	5
0	2	3	0	1	1	0	6	3
0	2	2	2	7	0	4	1	1
0	1	3	3	1	0	3	3	23
					0	2	5	37
				125	0	1	7	30
					0	0	9	22
					125			

To determine pairing relationships in the triploid, 125 cells in metaphase of the first meiotic division were studied. The various configurations that were observed are tabulated in Table 1. Because of their great difference in size the long and the short chromosomes are treated separately.

In 93 of the 125 cells, all twelve long chromosomes were associated in four trivalent configurations (Fig. 2). There were three trivalents with one bivalent and one univalent in 21 cells (Fig. 3). Seven cells had two trivalents, two bivalents, and two univalents, and one cell had one trivalent with three bivalents and three univalents. Three cells were more unusual. In one of these there were two trivalents but the six other long chromosomes were grouped as three bivalents. This arrangement suggests autosyndetic pairing between two chromosomes from one parent. In each of two other cells there was one trivalent, two bivalents, and one univalent, and the four other chromosomes were arranged in a quadrivalent configuration. A possible explanation for the quadrivalent is autosyndetic pairing between one of the chromosomes of a trivalent and a univalent chromosome. The 1,500 large chromosomes in the 125 cells were arranged in 2 quadrivalents, 454 trivalents, 45 bivalents, and 40 univalents.



FIGS. 2—7. Chromosomes during meiosis in a triploid *Gasteria*. FIG. 2. Metaphase of the first meiotic division showing the long chromosomes arranged in four trivalents and the short ones in two trivalents, one bivalent and one univalent. FIG. 3. Very early anaphase of the first meiotic division; the long chromosomes are in three trivalents, one bivalent and one univalent and the short chromosomes in one bivalent and seven univalents. FIG. 4. First anaphase showing six long and three short chromosomes going to one pole, six long and six short to the other pole, a chromatid bridge and an accompanying fragment. FIGS. 5—7. Metaphase of the microspore division; in FIG. 5 there are 4 long and 5 short chromosomes, in FIG. 6, 5 long and 7 short, and in FIG. 7, 7 long, 4 short and one intermediate-sized chromosome. FIGS. 2 and 3, $\times 1050$; FIGS. 4, 6, and 7, $\times 1225$; FIG. 5, $\times 1350$ after reduction.

Apparently in the triploid the small chromosomes pair much less frequently than the large ones for there were relatively fewer trivalents and more univalents. Of the 125 cells, none had three trivalents, only one had two, and only eleven cells had one. On the other hand, 22 cells had nine univalents and 89 cells had five or more. The 1,125 short chromosomes were organised into 13 trivalents, 189 bivalents, and 708 univalents.

The third set of long chromosomes would be expected to be distributed at random at first anaphase. In 45 cells, the distribution was 4—8 in five, 5—7 in 19, and 6—6 in 42 cells. This is entirely in accord with expectation. The short chromosomes are more difficult to observe accurately at first anaphase as they are often completely or partially hidden by the long ones. In 33 cells the distribution appeared to be 4—5 and in 13 cells apparently 3—6. Four of the anaphase cells had chromatid bridges and in three of these a fragment was readily recognised (Fig. 4). Bridges and fragments were also found in a small percentage of the cells in first telophase.

Sax and Edmonds (1933) have shown that in sterile plants of *Tradescantia* the pollen begins to abort shortly after the end of the second meiotic division. Most of the microspores that will develop no further are small and have a large number of granules in the cytoplasm. In this triploid *Gasteria* 2,100 microspores were examined and about 22 per cent. were small. The nucleus appeared to be in a very early prophase and both the nucleus and cytoplasm were highly granulated and appeared to be disintegrating slowly.

Most of the microspores that were not obviously aborting were in the resting stage, but many were dividing. Of 655 cells in metaphase, 22 had four long chromosomes (Fig. 5), 154 had five (Fig. 6), 285 had six, 164 had seven (Fig. 7), and 30 had eight. There is an excess of the six-chromosome type over expectation. The fact that no cell has fewer than four or more than eight is to be expected from the configurations at first metaphase. The short chromosomes were clear in only 650 cells. Eighty-nine cells had three, 250 had four (Fig. 7), 205 had five (Fig. 5), and 97 had six. The high percentage of univalents at first metaphase indicates that some cells might have fewer than three or more than six. Actually, one cell had no short chromosomes, 2 cells had two, and 6 cells had seven (Fig. 6). The small percentage of cells with fewer than three or more than six short chromosomes may possibly be accounted for by the early abortion of most of the cells with the more unstable numbers. One of the cells that had four short chromosomes had seven long ones and one of medium size (Fig. 7). The medium-sized chromosome may have arisen by reciprocal translocation or fragmentation.

Over 750 mature pollen grains were examined in aceto-carmin and 46 per cent. appeared large, deeply-stained, and viable; the others were shrunken and obviously aborted.

DISCUSSION.

This plant is of interest because it is the first triploid reported in the genus *Gasteria*. Its origin is unknown but there is some reason to believe that it is a hybrid between *G. sulcata* and *G. nigricans*. Presumably it arose from the union of a gamete which developed without reduction and a normal, haploid gamete. This explanation is plausible, for the writer has observed a very small percentage of large pollen grains which are probably diploid in a number of plants of *Gasteria*. In addition, in one plant of *G. sulcata* seven microspores out of 422 had eight long and five or six short chromosomes, and these microspores were much larger than those with the usual four long chromosomes.

The high frequency of trivalent configurations among the long chromosomes indicates such a close homology among the three sets of chromosomes that this plant appears to be essentially an autotriploid. The high percentage of univalents among the short chromosomes, however, is not easy to explain. In the diploid plants which the writer has examined, the short chromosomes usually pair almost completely. This was found to be true in single individuals of *G. sulcata*, *G. laetepunctata*, *G. obtusifolia*, and *G. planifolia* $\times$ *G. sulcata* which had been received from the Huntington Botanical Garden, in a specimen of *G. acinacifolia* from the United States Bureau of Plant Industry, and in *G. nigricans*, *G. nigricans* var. *fasciata*, *G. parviflora*, and *G. nitida* from the National Botanic Gardens of South Africa at Kirstenbosch. Only in two hybrids from the Huntington Botanical Gardens labelled *G. pulchra* $\times$ *G. planifolia* and *G. verrucosa* $\times$ *G. brevifolia* were any univalents observed and they were relatively very few. In interpreting the relatively low frequency of pairing amongst the short chromosomes in the triploid, one might assume that the short chromosomes have a very short locus of chiasma formation. Perhaps the presence of three homologues causes a very slight delay in pairing which inhibits chiasma formation. In the diploids there are only two homologues, there is no difficulty about pairing and there are few univalents.

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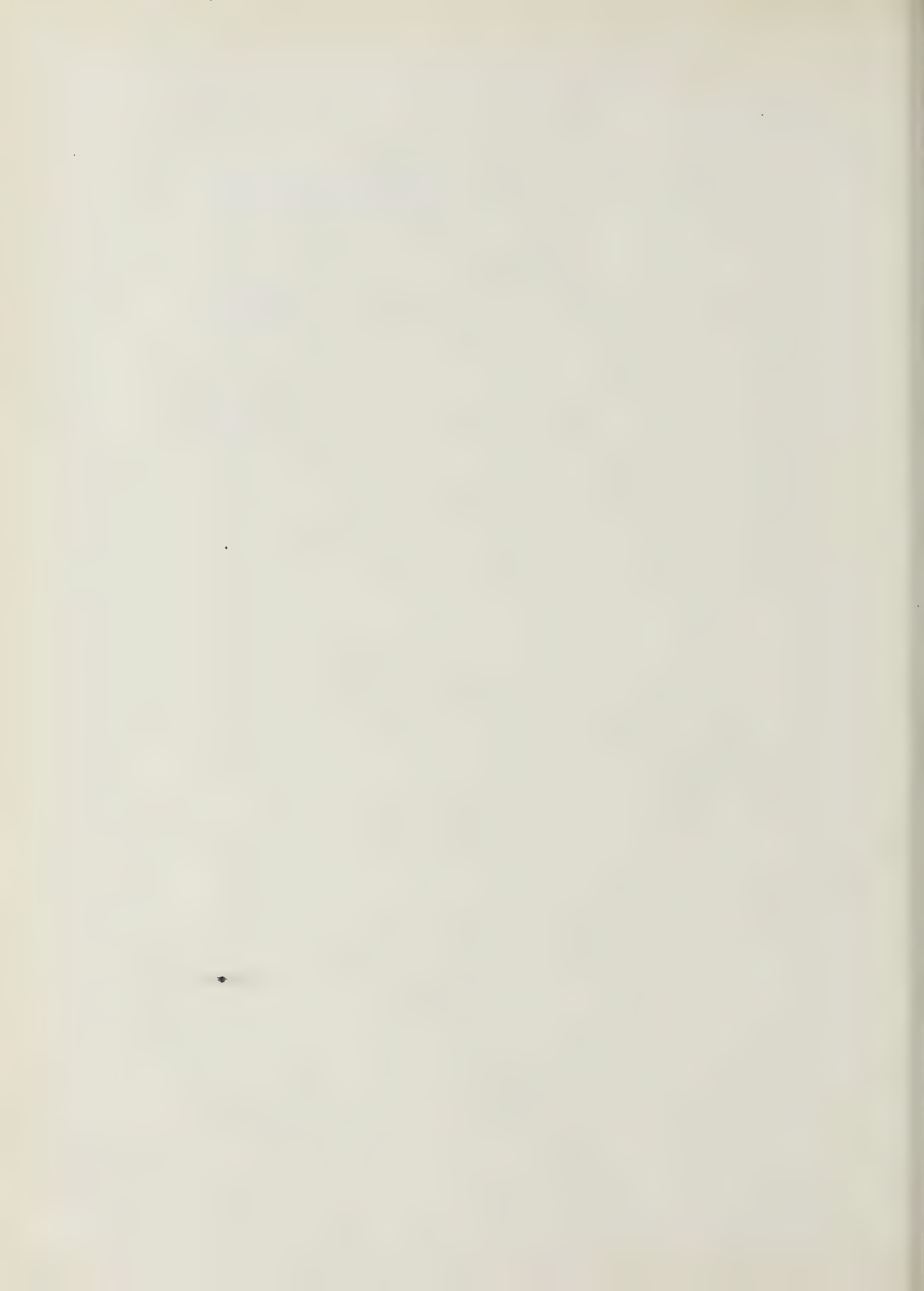




PLATE XI.—A triploid Gasteria.

THE FIRST FLOWERING OF *WELWITSCHIA MIRABILIS* HOOK F. RAISED FROM SEEDS.

(With Plate XII.)

By H. HERRE, Dipl. G.I.

(Curator of the University Botanic Garden, Stellenbosch.)

As early as in 1927 the Botanic Garden of the University of Stellenbosch received some seeds of the *Welwitschia mirabilis* by the courtesy of the late Prof. R. Marloth, from Cape Town. They were so many, that the old professor told me, that we will now be able to plant an avenue of it from the Stellenbosch railway station right up to the botanic garden. But *hélas*, not all he gave me germinated. They were sown on December 24th, 1927. I raised them in our ordinary leaf-mould soil mixed with concrete sand. Quite a lot of them went on nicely and now the question arose how to treat them further. Happily we could buy at that time some drainage pipes and cemented them on one side. As the plants strongly dislike any mica in the soil, but otherwise like to grow in decomposed granite, I tried to get it here. It was not so easy, but at least I got some. I mixed it up with some leaf-mould, filled the drain-pipes with it and planted the young *Welwitschias* in it. During the first year and also some years afterwards we kept the plants outside during summer, but as we lost some of them owing to unexpected rains, we now also during summer grow them in one of our succulent conservatories. As they are difficult to handle, all our eight plants stand on their present places already for some years. During last year we noticed, that one of them made some excrescence and during this year it grew further and developed into two small cones, which will probably grow further and may be female ones, at least we hope so. Some pictures of the plant and the cones will show things more clearly than long explanations will do. As it is not as hot here as in their home, they will probably grow much longer till they are fully developed and we hope the best for them. It would be a pity, if they would not develop further, but fall off.

The plants needed about 20 years time till the first one starts flowering, while all the others give no sign of it at all. At least one knows now besides the necessary age for forming a cone, a bit more about the age of older plants, if comparing the width of the leaves with those of our plants which are now 7—10 cm. broad. According to that, these plants much reach hundreds of years of age.

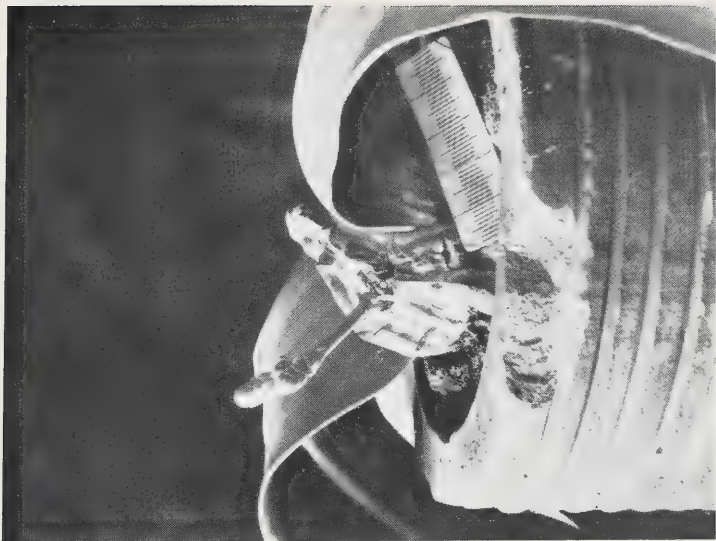
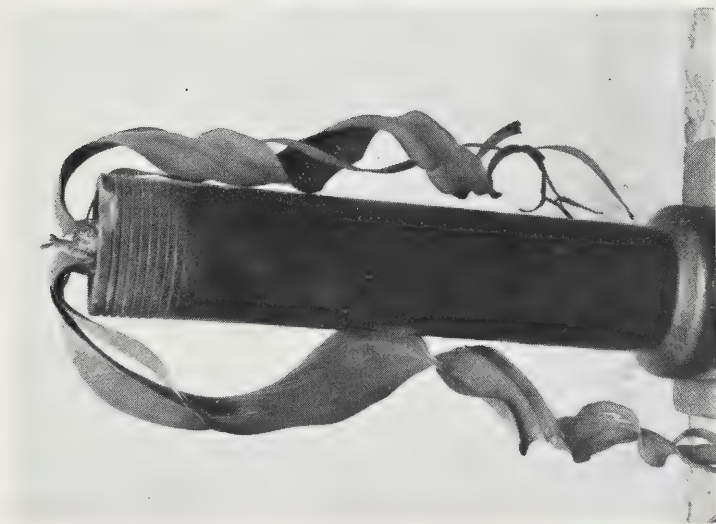


PLATE XII.

Welwitschia mirabilis. Seedling, sown December, 1927, flowering for the first time
December, 1947, in Stellenbosch University Botanic Garden.

THE CHROMOSOME NUMBER AND KARYOTYPE OF SENECIO ISATIDEUS DC.

By E. P. GOLDSMITH and S. KRUPKO.

(With Plates XIII and XIV.)

I. INTRODUCTION.

Almost a century after the species had originally been described (de Candolle, 1837), Steyn (1931) included *Senecio isatideus* DC. in a list of plants that he had proved toxic and that had not previously been recorded as poisonous. This plant and the alkaloids isolated from it have been studied chiefly from toxicological and chemical points of view. de Waal (1939) reported that the species has isatidine as the main alkaloid with lesser amounts of retrorsine. He investigated the hydrogenation, hydrolysis and chemical structure of isatidine (de Waal, 1940) and also the chemical structure of its necine and necic acid (de Waal 1941 *b* and 1941 *c*). The toxicity and pathological systems produced by the species and its alkaloids have been investigated by Steyn (1934), Steyn and van der Walt (1941) and Harris, Anderson and Chen (1942).

An intensive search through the literature brought to light no reference to the cytology of the species. It was hoped, therefore, that the present study would help to fill this gap in our knowledge.

2. METHODS AND MATERIALS USED.

I. METHODS USED IN STUDYING THE CHROMOSOMES AT MEIOSIS.

The following statement recently made by Darlington and La Cour (1942) gives some indication of the great importance modern cytologists attach to smear and squash preparations. "Sections have now been largely replaced by smears and squashes for all but the smallest masses of material." As is well-known, the advantages of these methods are rapidity of fixation, rapidity of handling without embedding and integrity of the nucleus.

For convenience, the first and second meiotic divisions will be referred to simply as I and II.

(a) *Material.*

The plants selected for study were found growing along the left bank of the stream below Murray's dam at Frankenwald, the Botanical Research

Station of the University of the Witwatersrand, near Johannesburg. Before the beginning of the 1945-46 growing season, rhizomes were transplanted from here to a flower bed near the Biology Block in the University grounds at Milner Park, Johannesburg. The plants which grew from these rhizomes were healthy and sturdy, and squash preparations of the pollen mother cells were made from the anthers of the floret buds of the young capitula produced in November and December, 1945. Specimens from both Frankenwald and Milner Park pressed later in the season and taken to the National Herbarium, Pretoria, were identified as *Senecio isatideus* DC. (See Plate XIII.)

(b) *Temporary preparations.*

The aceto-carmin squash technique (Schneider, 1880 ; Heitz, 1926) was used with intermittent heating (McClintock, 1929). The anthers were mounted and squashed singly. The anther was so small that the cover slip came into direct contact with the pollen mother cells, making it unnecessary to remove the anther walls or any other debris. The edges of the cover slip were sealed (McClintock, 1929) and drawings were done immediately.

The most troublesome part of the procedure was to find pollen mother cells at the metaphase stage. The stage of nuclear division could not be correlated with the external appearance of any part of the plant, and there was no alternative but to select at random the anthers for squashing. The fact that so few metaphases were encountered for so many late prophase and so many anaphases indicated that the intervening metaphase must be of short duration. Not only were the anthers in a single floret at widely different stages, but sometimes the pollen mother cells of a single anther would show all stages from early prophase I to telophase II. Often days at a time would pass in which not a single metaphase was seen, in spite of observations showing that meiosis proceeded actively from 6 a.m. throughout the day till 9 p.m. (No observations were carried out from 9 p.m. to 6 a.m.). All attempts to see the first post-meiotic division were unsuccessful.

Three modifications of the technique were tried with the following unsatisfactory results :—

(1) Squashing the anther and removing the larger fragments of debris before placing the cover slip in position involved damaging and losing a large proportion of the pollen mother cells.

(2) Keeping the anther in a variation of Carnoy's fixative—4 volumes of absolute alcohol to 1 volume of glacial acetic acid—for 24 hours prior to squashing (McClintock, 1929) did not improve the staining sufficiently to justify including this modification in the routine procedure.

(3) Smear methods could not be used as the anthers were small and not sufficiently succulent.

(c) *Permanent preparations.*

The same technique for squashing was used as for the temporary preparations. The cover slip was fastened into position on the slide with a brass paper fastener as suggested by Müller (1945). Held together in this way, the slide and cover slip were passed through a series of acetic acid—95% alcohol solutions (McClintock, 1929), then into dioxan; and finally the preparation was mounted in dioxan balsam. Dioxan made by J. T. Baker Chemical Co., Phillipsburg, N.J., was used with good results.

(d) *Microscope and drawing apparatus.*

The optical system used to study and draw the chromosomes consisted of a $15\times$ eyepiece, an achromatic, $97\times(1\cdot88\text{ mm.})$, $1\cdot25\text{ N.A.}$ oil immersion objective (Bausch & Lomb) and a $1\cdot25\text{ N.A.}$ Abbé condenser. The total magnification obtained with this eyepiece and objective was $1455\times$. Drawings were done at table level with the aid of a camera lucida, giving a magnification of $2800\times$.

II. METHODS USED IN STUDYING THE CHROMOSOMES AT MITOSIS.

Sections of the root tips were cut in order to obtain evidence as a check, and to supplement the observations made, on the squash preparations of the pollen mother cells.

Haematoxylin was selected as the stain most likely to remain intense permanently.

(a) *Material.*

Early one morning, a few days after the first heavy spring rains of the 1945–46 growing season, rhizomes were dug up below Murray's dam. The soil was removed by dipping the plants in the stream and the tips of the season's new roots were fixed in the way described on pp. 9 and 10. The plants were taken to the laboratory during the time the roots were soaking.

Various methods were tried to induce the production of new roots from rhizomes transplanted to flower pots or kept, both with and without Spergon, between damp sheets of blotting paper in an oven at 35°C . The following cutting treatments were tried:—

- (1) No cutting treatment.
- (2) Roots all cut off about an inch from the rhizome.
- (3) Roots all cut off a few millimetres from the rhizome.

(4) Half the roots on the rhizome cut as for (2), the other half receiving no cutting treatment.

(5) Half the roots on the rhizome cut as for (3), the other half receiving no cutting treatment.

Each of these cutting treatments of the roots was combined in turn with each of the following soaking treatments at room temperature of the roots and their cut ends immediately after cutting :—

(1) No soaking treatment.

(2) Soaking in tap water for 6 hours.

(3) Soaking in tap water for 4 hours and then in Hortomone A solution of " the normal strength " for 16 hours.

(4) Soaking in tap water for 4 hours and then in Hortomone A solution of " half the normal strength " for 16 hours.

The Hortomone A solutions were made up as directed in the literature accompanying the preparation, which is distributed by Plant Protection, Ltd., Yalding, Kent.

Each of the above cutting and soaking treatments of the roots was combined in turn with both the following treatments of the leaves :—

(1) No cutting treatment.

(2) Leaf blades all entirely cut off.

The plants grown in flower pots were dug up at weekly intervals and, after careful removal of the soil in a gentle trickle of tap water, inspected for root development. The plants kept in damp blotting paper at 35° C. were inspected daily. Those which had been treated with Hortomone A were soaked once a fortnight for a further 16 hours in a freshly made-up solution of the same " strength " as in the original treatment received, before replacing in the flower pots or in the oven.

None of the treatments induced the production of more than a few extremely slender new branches arising from the old roots, even after they had been continued for several months.

(b) *Fixation.*

The following fixatives were used as described :—

A.—Modifications of Navashin Fixative.

(1) *S. Navashin fixative* (M. Navashin, 1934).

The following formula was used :—

1 ml. glacial acetic acid

4 ml. 16% formaldehyde

10 ml. 1% chromic acid.

Using tap water for the soaking treatments, root tips were fixed under the following conditions :—

(a) in the field (protecting the fixative from direct sunlight) ;

- (b) after soaking in water at room temperature for 2, for 3, for 4 and 6 hours ;
- (c) after keeping at 2° C. without water for 6 or 14 hours, and then soaking in water at room temperature for 15 minutes ;
- (d) after soaking in water at 2° C. for 6 or 14 hours, and then in water at room temperature for 15 minutes.

(2) *Stockholm fixative* (Maheshwari, 1939).

The following formula was used for solution A :—

1 gm. chromic acid
10 ml. glacial acetic acid
65 ml. distilled water.

The following formula was used for solution B :—

40 ml. 40% formaldehyde
35 ml. distilled water.

After soaking in tap water at room temperature for 3 hours, root tips were fixed in equal volumes of solutions A and B freshly mixed together.

(3) *Taylor's modified Karpetchenko fixative* (Johansen, 1940).

The following formula was used :—

1.5 ml. 10% chromic acid
10 ml. 10% acetic acid
0.83 ml. 40% formaldehyde
23.67 ml. distilled water.

Root tips were fixed after soaking in tap water at room temperature for 2 hours.

B.—Modifications of Lewitsky Fixative (Avdulow, 1931).

As Lewitsky's (1931) original publication was unobtainable in South Africa, the formulae given by Avdulow (1931) were followed, trying both possible interpretations for his "10% formalin."

Root tips were fixed in each of four modifications of Lewitsky fixative after soaking in tap water at room temperature for 1 hour.

In addition, root tips were fixed in Lewitsky fixative for big chromosomes with 4% formaldehyde after soaking in tap water at 2° C. for 14 hours and then in tap water at room temperature for 15 minutes.

The root tips were gently boiled in freshly mixed fixative at room temperature for 10 minutes, using a water suction pump to reduce the pressure. Root tips fixed in the field were taken with the least possible delay to the laboratory, where they were boiled in the same way. Before washing, root tips fixed with modifications of Lewitsky fixative were kept in 1% chromic acid for 3 days (Navashin, 1934).

(c) *Staining.*

After bleaching, Heidenhain's well-known haematoxylin-iron-alum schedule for staining was followed. It was found necessary to bleach the sections before staining because of the presence of tannins. If the sections were not bleached, the chromosomes were obscured by darkly-staining globules of various sizes. When sections of fresh root tips were placed in 10% ferric chloride with a little sodium carbonate (Johansen, 1940), the globules turned a bluish-green colour, indicating the presence of tannins. The method of bleaching depended on the fixative used.

(1) After modifications of Navashin fixative, the slides were left in Stockwell's bleaching solution for 24 hours. The following formula for this solution was used :—

- 90 ml. distilled water
- 1 gm. potassium dichromate
- 10 ml. glacial acetic acid
- 1 gm. chromic acid.

According to Johansen (1940), the chromic acid renders the precipitated tannins soluble, the acetic acid removes them and the potassium dichromate acts as a catalyst in preparing the tissues for very sharp staining.

(2) After modifications of Lewitsky fixative, the slides were left in 1% chromic acid for 4 days. Stockwell's bleaching solution could not be used on account of the acetic acid it contains, but chromic acid by itself bleached the tannins sufficiently well.

After modifications of Lewitsky fixative the slides were left in 6% iron alum for 24 hours for mordanting before transferring to the haematoxylin solution.

(d) *Thickness of sections.*

After considering the results obtained with the usual preliminary sections, it was decided to cut transverse sections at 8μ for counting the chromosomes and for comparing the effects of the different methods of fixation used, and at 7μ for studying the morphology of the chromosomes. Only metaphases in the periblem and epidermis were examined and, before making any critical observations, the neighbouring sections on either side were inspected to make sure that no nuclei that had been damaged in cutting were studied.

3. OBSERVATIONS MADE.

At metaphase I of meiosis, the chromosomes were present as the monoploid number of tetrads of which, whenever they were well spread out, there were invariably 10. As seen from the direction of the spindle pole, the chromosomes appeared more or less square in outline, and the

four chromatids of the tetrad could frequently be distinguished (see Plate XIV, Fig. 10). Sometimes, however, only the bivalent structure was visible and even this was not always discernible. In these cases, there seemed to be no reason to doubt the actual presence of the tetrad and it was assumed that, by some coincidence of staining or due to the fact that the view obtained of the particular chromosome was not strictly polar, the tetrad structure was not obvious. The chromosomes differed from one another only slightly in size and shape and, as has usually been found in plants at this stage, the shapes of the individual chromosomes varied from one pollen mother cell to another, making it impossible, with perhaps a single exception, to recognise the chromosomes by their morphological peculiarities. In many pollen mother cells, a particular chromosome in the metaphase configuration was slightly turned away from the pole, revealing an elongated form characterised by two constrictions set at about even thirds along its length and a fairly pronounced tendency to be V-shaped (see Plate XIV, Figs. 4, 5, 10). It is very tentatively suggested that this chromosome may be identical either with chromosome IX or X or with both these chromosomes in the root tips (see below). In equatorial view, the chromosomes were more or less oblong in outline. In spite of the fact that no sort of pretreatment for structure was ever used, the coiled chromonemata were often observed. In some polar views of the metaphase plate, certain of the chromosomes were turned away from the pole and were seen in views intermediate between polar and equatorial. In the latter chromosomes, the spirals appeared as fine lines (see Figs. 6*a*, 6*c* and 10). In equatorial view the spirals showed as broad bands (see Figs. 7*a*, 7*c*). Anaphase I showed unfailing regularity.

In polar view, the chromosomes also appeared more or less square in outline at metaphase II and the two chromatids of the dyad were usually visible. Anaphase II showed unfailing regularity. Telophase II was immediately followed by cytokinesis and the pollen mother cell was divided simultaneously into four young pollen grains.

Whenever the chromosomes in the root tips lay well enough separated from one another to display their number, there were invariably 20 to be counted. The metaphase chromosomes in the root tips, as has usually been found in plants, did not show, with the one exception already referred to, and further discussed below, any marked resemblance to the chromosomes seen in the pollen mother cells. In general, they appeared very slender in comparison with the latter. After fixation with S. Nava-shin fixative in the field, the chromosomes were swollen to different degrees and varied in diameter from 0.30 to 0.60 μ with a mean of 0.45 μ . Although the chromosomes were interlaced to a large extent, it was

possible to establish the identity of the 10 homologous pairs by combining the observations made on a few selected metaphase plates (see upper row of chromosomes Fig. 1). The chromosomes were only of medium size, yet they were well differentiated morphologically. Further, while the cytogenetic aspect of the matter was not investigated, it was noted that the morphology of each type varied only over the small range usual for plants not of complex hybrid origin. Individual chromosomes could, thus, be recognised by their characteristic forms in other metaphase configurations examined later. The morphological peculiarities of the chromosome complement are summarised in the following table which is amplified in the discussion below.

<i>Pair.</i>	<i>Approximate Shape.</i>	<i>Kinetochores.</i>	<i>Secondary Construction.</i>
I C		Not obvious	One obvious
II S		Distinct ..	Two obvious, one in each curve
III L		Not obvious	Not obvious
IV Rod		Distinct ..	Not obvious
V V with arms unequal..		Not obvious	Not obvious
VI V with arms equal ..		Not obvious	Not obvious
VII V with arms equal ..		Distinct ..	Not obvious
VIII V with arms unequal..		Distinct ..	One very conspicuous
IX V with arms equal ..		Not obvious	Two obvious, one about the middle of the arm, the second in the other arm but slightly more towards the bend of the V than the middle of the arm
X V with arms equal but usually slightly longer and of slightly smaller diameter than chromosome IX		Not obvious	Two obvious, one about the middle of each arm.

It must be pointed out that, in all cases, the remarks on the kinetochore, though probably valid, may be open to correction, since neither the detailed structure of the region in question nor the rôle it played at anaphase were investigated. Where no constrictions whatever were observed in the chromosomes, it was assumed that the position of the

kinetochore would, without doubt, be revealed by methods of fixation specially adapted to the study of this organ rather than the general morphology of the chromosome. Where it is stated that, while secondary constrictions were visible, the kinetochore was not seen, it was concluded that the constrictions observed would be unlikely to function as the kinetochore. This conclusion was based on our knowledge of the position of the kinetochore definitely established for the great majority of chromosomes of a similar shape previously studied in other species.

The chromosome complement consisted of members of five distinct shapes, namely C, S, L, rod and V. One pair of each of the first four shapes was present, and no less than six pairs of V-shaped chromosomes. In the C-shaped type, the constriction was always located approximately where the top of a cedilla would come in a printed letter "C" (see upper row of chromosomes, Fig. 1). It may be noticed that the members of the pair drawn display a striking difference in diameter, but attention has already been called to the varying degrees of swelling shown by the chromosomes after fixation with S. Navashin fixative in the field. S is a shape rarely recorded for chromosomes in plants. It seems uncertain, however, whether it is really uncommon or just difficult to detect as, owing to its curved form, it may come to lie in a large number of different planes, its true morphology thus escaping recognition. In the present investigation the S chromosome was comparatively easy to see. The constrictions were set at about even fourths along the length of the chromosome and the middle one was taken to be the kinetochore. It is not for a minute suggested that the possession of a mere split end could, with any justification at our present state of knowledge, be regarded as the morphological peculiarity of a single type of metaphase chromosome, since all chromosomes are known to undergo a longitudinal splitting at this stage. However, it is surely noteworthy that, while none of the other chromosomes of the set ever displayed a visible double structure, the L-shaped type was always clearly seen to be split along about half its length, even after fixation with Stockholm fixative (see Plate XIV, Fig. 13) when only some of the morphological details were preserved. The rod-shaped type was characterised by a slight but definite swelling, starting a little to one side of the kinetochore and increasing gradually towards the end of the rod on the same side.

Three morphological characters served to distinguish the V-shaped chromosomes from one another, namely, the number of constrictions, the arm length ratio and the angle at which the arms were set. These distinguishing features are written in order of their constancy in the morphology of the chromosomes from which, of course, derived their

relative importance as guides to classification. On the basis of the number of constrictions seen, the V-shaped chromosomes could be classified into three groups with two, one and three pairs of chromosomes respectively, as follows :—

A.—Chromosomes with no constrictions visible (chromosomes V and VI).

(1) Chromosome V had one arm about two-thirds the length of the other, with the angle of divergence up to 60° .

(2) Chromosome VI had both arms about equal in length and diverging at 90° or more. It may be remarked that the members of the pair drawn for chromosome VI display, as do the members of the pair drawn for chromosome I, a striking difference in diameter, but the reader is again referred to the measurements given on page 00 for confirmation that this is not due to a drawing error.

B.—Chromosomes with one constriction visible (chromosome VII).

(1) Chromosome VII had the solitary constriction, which was taken to be the kinetochore, situated in one arm very near the region of forking of the V, though never exactly in the fork. Both arms are about equal in length and diverge at an angle of 90° or more.

C.—Chromosomes with two constrictions visible (chromosomes VIII, IX and X).

Of all the chromosomes in the set, the individuals of the three types in this last group exhibited the widest variation in morphology. The angle at which the arms were set varied over such a wide range in each of the types that any figures given should be of little or no value.

(1) Chromosome VIII was easily distinguished from the other two types because, firstly, it had a more or less centrally-placed constriction which was taken to be the kinetochore and, secondly, although the arm length ratio varied so widely that a statement of its numerical limits would convey no meaning, the arms were usually unequal in length. The V was curved rather than pointed, and the variation in the position of the arc with alteration in the arm length ratio seemed to have no particular relation to the position of the kinetochore. Furthermore, chromosome VIII was unique, not only among the members of group C of the V-shaped chromosomes, but also among the members of the entire set, in the conspicuousness of its secondary constriction, which was several times as long as the kinetochore and located near the end of one of the arms. This constriction was probably associated with the organisation of the nucleolus.

(2) It might be concluded from the table and from Fig. 1, that chromosomes IX and X were almost identical but, strangely enough, these two types were seldom if ever confused when examining the preparations. Nevertheless, it cannot be denied that they resembled one

another closely and that both of them resembled, to some extent, the only chromosome which was identified as an individual at metaphase I of meiosis, namely the longish chromosome tending to be V-shaped and with two constrictions set at about even thirds along its length (see Plate XIV, Figs. 6e, 5c and 10). However, two such individuals were seen once only in one and the same metaphase (see Fig. 10) and further study would be needed to verify that the observations at meiosis had not been confined to a single individual but rather to two chromosomes with the

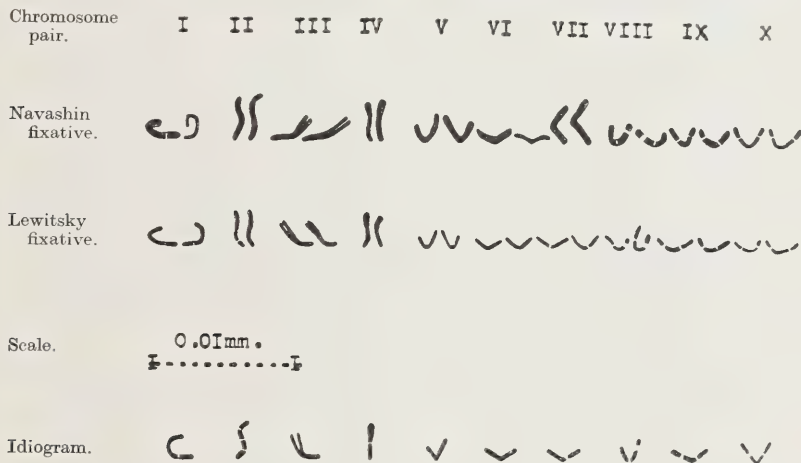


Fig. 1.

The karyotype drawn from root tip metaphases after fixation with S. Navashin fixative (upper row of chromosomes) and Lewitsky fixative for big chromosomes with 4 per cent. formaldehyde (middle row of chromosomes). Homologous pairs of chromosomes and scale—2130x. Idiogram approximately 2130x.

same degree of similarity as chromosomes IX and X in the root tips, and to establish the identity of these chromosomes with chromosomes IX and X.

Soaking at room temperature for 2 hours prior to fixation decidedly improved the spreading of the chromosomes at the metaphase. Soaking for 3 hours led to a further marked improvement in the spreading. After soaking for 6 hours, however, the chromosomes were badly entangled and, in many cases, gave the impression that mitosis had stopped at late metaphase.

Cold treatment for 6 hours in the absence of water prior to fixation brought about a pathological condition in the tissues. The cells were

plasmolysed, the stainability, especially of the nuclei, was increased and the chromosomes showed varying degrees of shrinkage. Deeply stained chondriomes were seen. After cold treatment for 14 hours in the absence of water, the pathology was further advanced and the chromosomes had coalesced into a shrunken mass.

Soaking at 2° C. for 6 hours shortened and straightened the chromosomes and improved their spreading (see Fig. 12). The members of the chromosome complement differed only slightly from one another in shape, the constrictions were not visible, and it was no longer possible to recognise the individual chromosomes by their morphological characters. Soaking at 2° C. for 14 hours led to a further improvement in the spreading with which, however, the chromosomes came to occupy several horizontal planes. The ordinary two dimensional drawing, therefore, does not reflect the real improvement made in the preparation. When soaking at 2° C. for 14 hours was followed by fixation with S. Navashin fixative, the chromosomes varied in diameter from 0.58 to 0.87 μ with a mean of 0.63 μ . Although the lower limits of the latter range overlapped slightly the upper limits of the range of diameters after fixation with S. Navashin fixative in the field, the mean diameter was greater by half nearly, and it might be concluded that soaking at 2° C. probably tended to increase the chromosome diameter. This increase was more clearly demonstrated by the use of Lewitsky fixative (see below).

After Stockholm fixative, the chromosomes were fairly uniformly swollen, varying in diameter from 0.45 to 0.75 μ with a mean of 0.60 μ . The chromosomes were well spread and some of the morphological details were preserved (see Fig. 13).

After Taylor's modified Karpetchenko fixative, the metaphase presented much the same appearance as after S. Navashin fixative.

After all four modifications of Lewitsky fixative, the chromosomes were thinner than after S. Navashin fixative and comparatively uniform in diameter, varying only from 0.25 to 0.35 μ with a mean of 0.30 μ . In spite of their thinness, however, the chromosomes were no better spread than they were after the latter fixative, nor were the constrictions noticeably easier to see. The best contrast between the staining of the chromosomes and cytoplasm was obtained after Lewitsky fixative for big chromosomes with 4 per cent. formaldehyde. As the percentage of the formaldehyde was gradually increased according to the different modifications of the formula, the contrast deteriorated steadily but, with careful differentiation, moderately good preparations could be made even after Lewitsky fixative for small chromosomes with 10 per cent. formaldehyde. Comparatively few mitochondria and leucoplasts were seen. The fact that after Lewitsky fixative for big chromosomes with 4 per cent.

formaldehyde the members of the chromosome complement showed essentially the same morphological characteristics as after S. Navashin fixative (see middle row of chromosomes, Fig. 1), confirmed the detailed observations on the peculiarities of the individual types described above. The use of a different fixative had little or no influence on the effects of preliminary soaking at 2° C. for 14 hours (see Fig 14). The chromosomes varied in diameter from 0.5 to 0.8 μ with a mean of 0.65 μ , that is over the identical range and with almost exactly the same mean as when this pretreatment was followed by S. Navashin fixative (see p. 111). From an inspection of the corresponding ranges and means it is quite evident that soaking at 2° C. had doubled the diameter of the chromosomes. On account of the varying degrees of swelling shown by the chromosomes after fixation with S. Navashin fixative in the field (see p. 110), the real extent of the increase in chromosome diameter produced by soaking at 2° C. was somewhat obscured by the use of the latter fixative, only a tendency to the same effect being discernible.

After S. Navashin and Stockholm fixatives the nucleolus in the resting cells was grey, and after Taylor's modified Karpetchenko and Lewitsky fixatives it was dark blue.

4. DISCUSSION OF OBSERVATIONS.

The present account is the first record, to the best of the writer's knowledge, of any cytological investigation of a South African species of *Senecio*. Ishikawa (1916), Okabe (1931) and Matsuura and Sutô (1935) in Japan, de Litardière (1922) in France, Afzelius (1924) in Sweden, Sokolovskaya and Strelkova (1938, 1940 and 1941) in Russia and Rutland (1941) in England give chromosome numbers for various species of *Senecio*, but, unfortunately, issues of most of the relevant publications are unobtainable in South Africa. Although photostat copies of the more extensive works were ordered nearly a year before the time of writing and enquired about in subsequent correspondence, they have still not arrived here owing to the abnormal conditions prevailing throughout the world. There is, therefore, no way of comparing either the methods used in the present investigation with those used by earlier workers or the morphology and behaviour of the chromosomes of *Senecio isatideus* with those of other *Senecio* species already investigated.

Without further special study, it would be impossible to decide on the number of genomes, each consisting of several chromosomes differing in form and function but acting together as a complete and harmonious system, making up the chromosome complement. The course of synapsis during prophase I was not traced, but the anaphasic distribution of the

chromosomes showed the unfailing regularity which characteristically follows normal synapsis. However, it should not be forgotten that the probable absence of multivalents might also have been the result of the combination of genomes, each of which was present only twice, or of a close genic similarity in the chromosome sets. In the light of current opinion, the restricted habitat might weigh against the possibility of the species being tetraploid because it has been found that, on account of physiological differences between diploids and tetraploids, the latter are often able to grow well in a wider range of habitats than the related diploids. As only one pair of chromosomes of each type was present in the root tip metaphase (see Fig. 1), the species is probably not autotetraploid, if indeed it is tetraploid at all.

M. Navashin (this reference could not be traced) is reported to have found that, as a general rule, the chromosomes tend to spread further away from one another as the turgor of the cell increases. Of the times of soaking at room temperature prior to fixation tried in the present investigation (see p. 111), 3 hours gave the best results.

The first record of the effects of cold treatment on chromosomes was published in 1931 (Delaunay, 1931). More recently, conflicting reports have been made by other workers in this field, and, in particular, Resende, de Lemos-Pereira and Cabral (1944) have attacked, with considerable rancour, the views held by Darlington and La Cour (1940). A summary of the main findings is included in the following part of the discussion, since, to the best of the writer's knowledge, they have not yet been reviewed. The results of observations parallel to those made in the present investigations are stated but no definite correlations are implied, as only a very limited amount of work was done on this aspect of the problem studied.

Delaunay (1931) discovered that keeping *Crepis* seedlings in finely chipped ice or snow for 24 hours caused complete straightening of the chromosomes with a diminution in length of 50 per cent. Darlington and La Cour (1940) found that, at a temperature at which mitosis stopped in some species, it continues in others but with varying degrees of abnormality, including "differential reactivity" and suppression of the spindle. The spindle is suppressed at marginal temperatures which produce cell anaesthesia without chromosome anaesthesia and this results in "superspiralisation" and "supercontraction" of the chromosomes. Resende, de Lemos-Pereira and Cabral (1944) found that the range of temperature over which the chromosomes decreased in length without showing signs of pathological mitosis was as limited as 1 or 2° C. and differed in each of the three species they studied. They maintain that there is an upper as well as a lower range of temperature over which the

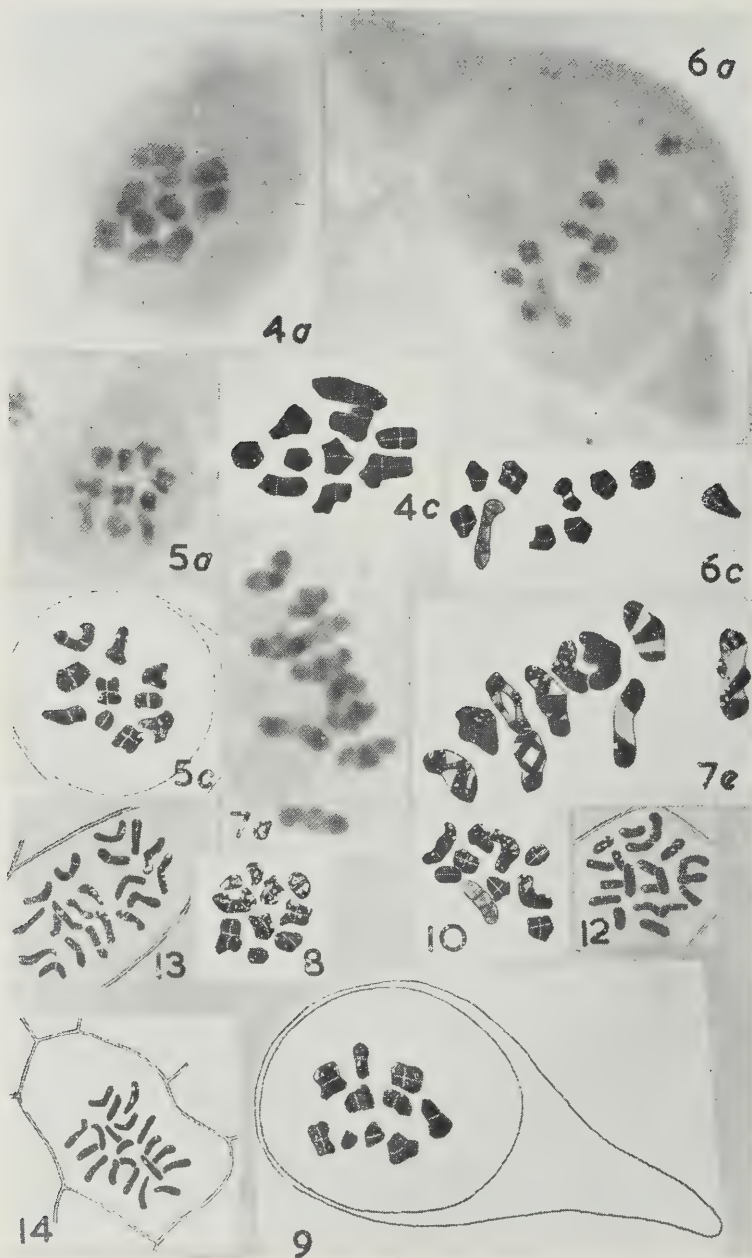


PLATE XIV.
(For explanation see opposite).

chromosomes contract. These writers are most critical of the "differential reactivity" described by Darlington and La Cour (1940). Hill and Myers (1945) noted that soaking in water at 2° C. contracted the elongated, overlapping chromosomes of *Dactylis glomerata* and two other forage grasses, facilitating the counting of the chromosomes. Warmke (1946) obtained shortened chromosomes with preservation of morphological details in many different grasses by soaking at 0° C.

2° C. was chosen as the temperature for cold soaking in the present investigation on account of the favourable results reported by Hill and Myers (1945) for three forage grasses receiving pretreatment at this temperature. In light of the findings of Darlington and La Cour (1940) and Warmke (1946) the disappearance of the constrictions (see p. 120) might seem unexpected. However, Resende, de Lemos-Pereira and Cabral (1944) assert that constrictions vary in chromaticity with temperature and become inconspicuous as they approach a completely "pachychromatic" state. (Constrictions with a chromaticity similar to that of the main body of the chromosomes are designated "pachychromatic" by these authors.) They pointed out that this variation was not correlated with the degree of contraction, declaring that they had seen the constrictions at their clearest in much contracted chromosomes. Hill and Myers (1945) found 24 hours the optimum time of soaking at 2° C. for three forage

PLATE XIV.

FIGS. 4—14. Squash acetocarmin.

- 4a. Photograph of a temporary preparation showing polar view of metaphase I. 1900x. Enlargement.
- 4c. Diagram of above. 2300x.
- 5a. Photograph of a permanent preparation showing polar view of metaphase I. Enlargement. 1900x.
- 5c. Diagram of above. 2300x.
- 6a. Photograph of a permanent preparation showing polar view of metaphase I. Enlargement. 1900x.
- 6c. Diagram of above. 2300x.
- 7a. Photograph of a permanent preparation showing equatorial view of metaphase I. Enlargement. 1900x.
- 7c. Diagram of above. 2300x.
8. Diagram of polar view of metaphase I drawn from a temporary preparation. 2300x.
9. Diagram of polar view of metaphase I drawn from a temporary preparation. 2300x.
10. Diagram of polar view of metaphase I drawn from a permanent preparation. 2300x.
12. Diagram of polar view of root tip metaphase after soaking at 2° C. for 6 hours prior to fixation with S. Navashin fixative. 2300x.
13. Diagram of polar view of root tip metaphase after soaking at room temperature for 3 hours prior to fixation with Stockholm—Navashin fixative. 2300x.
14. Diagram of polar view of root tip metaphase after soaking at 2° C. for 14 hours prior to fixation with Lewitsky fixative for big chromosomes with 4 per cent. formaldehyde. 2300x.

grasses. Warmke (1946), on the other hand, found $1\frac{1}{2}$ hours at 0°C . the optimum for many different grasses. In the present study good results were obtained after 14 hours at 2°C . Darlington and La Cour (1940) would attribute the increase in the diameter of the chromosomes with cold treatment (see p. 120) to suppression of the spindle in the absence of which the chromosomes continued to spiralise after the disappearance of the nuclear membrane, presumably developing major spirals. Resende, de Lemos-Pereira and Cabral (1944), on the contrary would attribute the increase in the diameter of the chromosomes neither to an increase in the diameter of the spiral nor to the formation of a greater matrical mass than usual, but to the condensation of the normal matrix around a smaller extension of the chromonemata.

From a consideration of relationships within the Compositae, Small (1919) concludes that the chromosome number is of some value in tracing the phylogeny of the genera of this family. His main thesis, founded on vegetative and floral morphology and physiological and cytological studies, is that *Senecio* was the first genus of the Compositae to come into existence, originating somewhere between the forests of the Amazon and the heights of the Andes, and that it has directly or indirectly given rise to all the other genera of the family. If Small (1919) is correct, chromosome studies on *Senecio* and genera closely allied to it would give further evidence of how evolution has progressed within the Compositae. Small (1919) states that his data indicate the 5, 10, 15, 20, 30, 60 series of chromosome numbers in the tribe Senecioneae as the primitive one, with the basic or original haploid number 5 occurring in the genus *Senecio*. Wanscher (1934) also considers that the basic number of *Senecio* is 5, reaching this conclusion from an inspection of Tischler's (1927, 1937 and 1938) lists of chromosome numbers. Darlington and Ammal (1945) consider that 5, 9, 12 and 30 are the basic numbers of the tribe Senecioneae and that 10, 11, 12 and 23 are the basic numbers of the genus *Senecio*. It may be mentioned that some of the species listed by Darlington and Ammal (1945) under "*Senecio* (*Cineraria*)" were at one time placed under the genus *Cineraria*. They were subsequently transferred to *Senecio* and are evidently still regarded as species of the latter genus by these writers. For the basic numbers of *Senecio*, Darlington and Ammal (1945) had reference to the chromosome numbers given by Sokolovskaya (1938, 1940 and 1941) as well as to Tischler's (1927, 1937 and 1938) lists. In spite of Afzelius' (1924) record of 5 chromosomes for *Senecio discifolius* which Tischler (1927) included in his lists, Darlington and Ammal (1945) apparently reject 5 as a basic number for the genus, though they do not give their reason for doing so. *Senecio isatideus* would thus have either twice one of the basic numbers, namely twice 5, according to the opinion

held by Small (1919) and Wanscher (1934) or one of the basic numbers itself, namely, 10, according to the opinion held by Darlington and Ammal (1945). In the former case, the species would be of tetraploid derivation and probably of allotetraploid derivation at that, since, as has already been pointed out (see p. 120), only one pair of chromosomes of each type was present in the root tip metaphase (see Fig. 1). In any case, *Senecio isatideus* can be added to the list of those species whose chromosome number is a multiple of 5, and, further, to the list of species—which takes in by far the greater number of *Senecio* species yet studied—whose chromosome number is an even multiple of 5, that is 10 and multiples of 10.

With the aid of the distinctive karyotype described in the present report, it may be possible to decide on the number of genomes composing the somatic chromosome complement in other species of *Senecio* and to determine their relationship to *Senecio isatideus*.

For the past thirty years, cytologists and taxonomists have been discussing the bearing of chromosome variation on classification in particular groups and, during the latter half of this period, it has been generally acknowledged that a simple determination of the chromosome numbers in plants may be of great importance for taxonomy and ecology. It has been found that differences in chromosome number, morphology and behaviour and variations in characters sometimes correlated with these differences are often useful in classifying varieties and related species. In view of these facts, the undeviating haploid count of 10, further borne out by the diploid count of 20, the constant and characteristic form of the metaphase chromosomes in the root tips by which individual chromosomes could be identified, and the repeated observation of normal anaphasic separation in the pollen mother cells in the present study of *Senecio isatideus* may well assume considerable significance when the cytotaxonomy of other species of *Senecio* is investigated, and the true natural relationships with their basis in community of origin are discovered.

5. SUMMARY.

In a study on some aspects of the cytology of *Senecio isatideus* DC., a species that is poisonous to grazing animals, temporary and permanent acetocarmine squash preparations of the first and second metaphases of meiosis were photographed and drawn. A haploid number of 10 was recorded.

The somatic chromosomes were studied in sections of root tips fixed in a variety of ways and stained with haematoxylin. A diploid number of 20 was recorded.

The karyotype was drawn after fixation with Navashin and Lewitsky fixatives and the idiogram was worked out. Soaking at room temperature for 3 hours improved the spreading of the chromosomes at the metaphase. Soaking at 2° C. for 14 hours shortened and straightened the chromosomes, increased their diameter and improved their spreading. The constrictions were no longer visible following this treatment.

Stockholm fixative gave the most satisfactory results for general purposes, combining good spreading with preservation of some of the morphological details.

To the best of the writers' knowledge, the present account is the first record of any cytological investigation of a South African species of *Senecio*.

6. ACKNOWLEDGMENTS.

We wish to thank Dr. J. Phillips, Professor of Botany at the University of the Witwatersrand, for suggesting the subject of this investigation and for allowing us the use of the facilities provided for research in his Department; Mr. A. Salbany for photographing the preparations; Dr. D. B. D. Meredith and Dr. D. Goldfoot for taking the photographs. One of the authors, E. P. Goldsmith, wishes to thank the Council of Scientific and Industrial Research for the sum of £50 which was part of a research grant awarded to her for the purpose of carrying out the investigation described.

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REVIEWS.

SWARTLAND AND SANDVELD. By W. J. Talbot, Cape Town, Oxford University Press, 1947. 10/6d. net.

It is a truism that all human progress and civilisation is dependent on the ability of the community to provide sufficient food. On the agriculturalist rests the whole structure. Agriculture itself is dependent on the soil and its continuance on the preservation of that soil. Loss of soil means a permanent loss of food; if extensive it may result in the downfall of human activities.

The sub-title of this volume, "A Survey of Land Utilisation and Soil Erosion in the Western Lowland of the Cape Province" explains its purpose. It is a study of one of the important grain-producing areas of South Africa and of this area it presents a most unsatisfactory picture. As a result of ignorance, carelessness or mistaken desires for immediate gain, soil erosion in one or other of its forms has affected practically the whole of the cultivated area and in parts has become really severe.

Working under the auspices of the Social and Economic Planning Council, Professor Talbot has written this book in the form of a report. As such it may well serve as a model of objective scientific observation and deduction without a trace of propaganda.

The area covered is the lowland region of the western Cape between Table Bay in the south and Moorreesburg and Saldanha Bay in the north. The book is divided into four chapters, the first being a description of the area, its configuration, climate and vegetation. Special mention must be made of the treatment of rainfall and the most striking maps illustrating not only its amount and distribution but also its reliability. This last is a most important factor in land utilisation in regions which have rainfalls near the lower limit possible for crops. The second chapter deals with Soil Genesis and Degeneration and is admirably clear. Theoretical matter is throughout related to local conditions and illustrated by local examples. The third and longest chapter is on soil erosion in the area itself and has descriptions of the varied forms that occur and their distribution and frequency. In all cases these are clearly related to the causative factors. The final chapter is devoted to conservation both as it should be and as it has been aimed at. Where conservation attempts have failed the reasons are clearly set out.

The summarisation at the end paints a picture of present conditions that can only be described as disastrous but the author does hold out a

real hope in a suggested conservation policy which, if implemented at once, does promise salvation for the agricultural future of the region.

The volume is very fully illustrated by excellent photographs, very clear diagrams and a number of clear maps. Several of the maps are based on aerial photographs. A feature of the book is the way the illustrations are used as a visual addition to and extension of the matter in the text. This enables the author to present a full picture but one nowhere overloaded with detail. At no time does the reader feel oppressed by masses of examples but rather has the attitude of asking for more.

The book is written in clear, non-technical language. It is very well produced and remarkably free from errors. It is one that should have a very wide appeal. All who are interested in the future of the country should study it if only because it is only by the pressure of public opinion that the conservation schemes proposed here can be brought to actuality. Without them this grain-producing area is liable to become a useless waste.

R. S. ADAMSON.

PLANTS AND PLANT SCIENCE IN LATIN AMERICA. Edited by Frans Verdoorn. Waltham, Mass., U.S.A., the Chronica Botanica Co.; Johannesburg, Central News Agency, Ltd. \$6.00. xl+ 384 pp., 83 pl. and text-illustrations. 1945. (A new series of Plant Science Books, vol. XVI.)

This impressive volume is a collection of essays and articles by many authors on almost every conceivable aspect of plant life, indigenous and cultivated, in what is called, for lack of a better phrase, Latin America, from Mexico to Cape Horn, including the West Indies and outlying islands. There are comprehensive chapters on Types of Vegetation (Johnston and Smith), Economic Botany (Fosberg), History (Pennell), and Problems of Tropical American Agriculture (Popenoe), and a large number of shorter articles on more special aspects. A valuable feature, typical of the aims of the Chronica Botanica editors, is the reference section. For instance, Lanjouw contributes an index to the Location of Central and South American Botanical Collections; there is a supplement which gives the names and addresses of botanical institutions, stations, museums, gardens, societies and commissions; there is a comprehensive bibliography and the indexes are excellent.

Several chapters can be read with profit in countries with similar problems, such as South Africa. For instance, Coolidge contributes Notes on Nature Conservation which show that in Latin America, just as in the Union, there is more aspiration than achievement in this direction. Bennett's contribution on Soil Conservation is all too reminiscent of his treatment of the parallel problem in South Africa.

Special praise may be given to the plates which are of a high degree of interest, and to the text-illustrations, maps, ornamental headings and end-papers. Dr. Verdoorn's own essay on *The Plant Scientist in the World's Turmoils* enables him to set forth his creed of international understanding and co-operation which is the mainspring of so much of his work through the *Chronica Botanica* organisation; and this volume aims at promoting inter-American relations. It is an indispensable source of information and guidance in the botanical and agricultural fields of the southern three-quarters of the New World; and Dr. Verdoorn is to be congratulated and admired for the way in which he has organised his team of collaborators, and on the general high standard of the book as a whole. The greater part of it is in English, with some chapters in Spanish and French.

R. H. COMPTON.

Chronica Botanica Publications (Waltham, Mass., U.S.A., *Chronica Botanica Co.*; Johannesburg, *Central News Agency*).

Merrilleana: A Selection from the General Writings of Elmer Drew Merrill. C.B., Vol. X, Nos. 3/4, pp. 127-394. 1946. \$4.00.

Nobody has contributed more to the knowledge of the floras of the Pacific and the Far East than Dr. Merrill. His innumerable studies have been published during a lifetime of administrative work in control of some of the greatest American botanical institutions. His influence has been felt in every aspect of historical botany, plant systematics and phytogeography in the United States, and the value of his work has been recognised by honorary fellowships and distinctions in many other countries. His writings have not been solely technical, and in the present volume there have been collected a number of his articles on the general aspects of his subject, all of interest to the student and many to the lay reader as well. Such are his studies of domesticated plants in relation to the diffusion of cultures, the connexion between the distribution of plants and of their local names, the problem of the so-called lost continents of Atlantis and Mu, and the full and instructive accounts of the exploration of Mount Halcon. Throughout one feels the vitality of the author and his keen sense of the intimate relation between botanical work and daily life. A valuable and stimulating record of the work and thought of an essentially human botanist, whose seventieth birthday the volume commemorates.

ARBER, DR. AGNES. Goethe's Botany. C.B., Vol. X, No. 2, pp. 63-126. 1946. \$2.00.

A translation of Goethe's "Versuch die Metamorphose der Pflanzen

zu erklären," 1790, and a reprint of his ode "Die Natur," 1782, with a new translation. Dr. Arber in an introductory essay attempts an estimate of Goethe's enthusiastic but rather amateur studies and the poetical and abstract bias which carried him into the realms of nature-philosophy. His influence on the botanical thought of his day was profound, but led to what Sachs called "inconceivable aberrations" among his followers. Dr. Arber thinks that Goethe was "a great biologist who, in the long run, overstepped the bounds of science."

RAFINESQUE, C. S. *A Life of Travels*. C.B., Vol. VIII, No. 2, pp. 291-360. 1944. \$2.50.

A reprint of the rare autobiography (of which only about twenty copies are known to exist) of this versatile but erratic traveller and naturalist (1783-1840), who published about 900 papers, mainly on North American subjects of the most varied kind. Dr. Merrill, who has done much to revive interest in this curious and exasperating character, contributes a foreword in which he attempts to give a more appreciative estimate of Rafinesque's pioneer work than has been current hitherto.

JACK, HOMER A. *Biological Field Stations of the World*. C.B., Vol. IX, No. 1, pp. 1-74. 1945. \$2.50.

A comprehensive list of biological field stations in all parts of the world, with their functions, publications, equipment, history and other relevant particulars. The compilation of this list represents an enormous amount of work, travel and enquiry, for which gratitude is owed to Dr. Jack, whose introductory chapters on topics connected with field stations are of great value for their interest and guidance.

WYMAN, DONALD. *The Arboretums and Botanical Gardens of North America*. C.B., Vol. X, Nos. 5/6, pp. 395-498. 1947. \$1.50.

This book can be strongly recommended to anyone who has the ambition of founding or endowing an arboretum or botanic garden, to anyone who is in control of such an establishment, and to anyone who wishes to know more about the various types of institutions of this kind. It is primarily a list of the North American examples, ranging from the few great institutions such as the Arnold Arboretum, "America's Greatest Garden," with its endowment of three and a half million dollars and an operating budget of \$90,000, the New York Botanic Garden (endowment \$3,500,000, budget \$400,000), the Missouri Botanic Garden (endowment \$5,000,000, budget \$150,000-\$200,000), Montreal Botanic Garden (budget \$165,000), down to the numerous small establishments, often converted private arboreta with a mere handful of employees.

Details are given of the aims and functions of these institutions—scientific, educational, aesthetic—and of their administration.

Apart from this reference section the book contains a remarkable collection of illustrations of botanic gardens, old and modern, in many parts of the world, many of them of rarity and curious interest; an informative introduction on the problems involved in establishing an arboretum or botanic garden and the methods which should be adopted; a bibliography; an index to small collections of special plants; as well as several other features. Dr. Wyman deserves cordial thanks for this valuable volume.

HOWARD, WALTER L. Luther Burbank, a Victim of Hero Worship. C.B., Vol. IX, Nos. 5/6, pp. 299-522. 1945/6. \$3.75.

L. H. Bailey gave what is perhaps the fairest picture of Luther Burbank when he said: "He is an honest, straightforward, careful, inquisitive, persistent man. He believes that causes produce results. His plants are the result of downright, earnest, long-continued effort. He earns them. He has no other magic than that of patient enquiry, abiding enthusiasm, an unprejudiced mind, and a remarkably acute judgment of the merits and capabilities of plants."

But Burbank has been converted by the methods of publicity, journalism, exploitation, idealisation, bigotry and ballyhoo into a fantastic figure—national hero, genius, wizard, charlatan, fraud, atheist, and goodness knows what besides. To call him the "victim of hero-worship" is to mention only part of his victimisation. Dr. Howard's study of the man and his achievements, though somewhat over-elaborate, is the best attempt that has been made to arrive at a just estimate of Burbank. It will be read with sympathy for the fate which has befallen this essentially simple character, whose orthodox and time-honoured methods of selection, so thoroughly applied, have led to such unenviable notoriety.

R. H. COMPTON.

K. STARR CHESTER. The Nature and Prevention of the Cereal Rusts as Exemplified in the Leaf Rust of Wheat. Waltham, Mass., the Chronica Botanica Co.; Johannesburg, Central News Agency, Ltd. 1946. pp. 269. Figs. 11. Price in U.S. 5.00 dollars.

Among its many excellent features, this book maintains the tradition of the *Annales Cryptogamici et Phytopathologici* that the author should be a recognised authority on the subject he writes about; it gives a welcome summary of Russian literature; and it describes those recent advances which have averted rust-induced wheat famines of the sort that were associated with World War I.

A purely parochial objection is that the book is primarily concerned with leaf rust, while South Africans would have preferred more about stem rust. But in this country we should study the cereal rusts in all their aspects, because rust is incomparably the greatest plant disease problem here. For it is rust that stops us growing wheat as a summer crop in the summer-rainfall area—the only area likely to give us a crop adequate for the country's needs—and gives us the official classification of wheat as a "winter cereal," a classification which must surprise those who know the blistering summer heat that wheat stands in much of N. America and Eurasia.

The printing and binding of the book conform with previous volumes in the series, which is to say they are excellent.

J. E. VAN DER PLANK.

J. B. HUTCHINSON, R. S. SILOW and S. G. STEPHENS. *The Evolution of Gossypium and the Differentiation of the Cultivated Cottons.* Oxford University Press. 1947.

Alterations in the policy of the Empire Cotton Growing Corporation and its decision to concentrate its research activities largely in Uganda and the basin of the Upper Nile have meant the passing of the Cotton Research Station in Trinidad, and, nearer home, the closing of the long familiar station at Barberton in the Transvaal. These changes, though clearly matters of the Corporation's policy, have not been made without regrets, felt amongst a wider public than the staffs of the stations themselves, for the high standard of the work at each of them had lead them to be held in very high esteem by geneticists, agriculturalists and botanists alike. "Tis an ill wind" however, for the closing of the Trinidad station has lead to the preparation of this very excellent little book. It is the result of twenty years of patient research and is one of those delightful biological syntheses in the field of genetics which we are more accustomed to expect from the pen of an author with a short-lived insect as experimental material.

Some years ago Ford and Huxley produced a similar book, dealing mainly with Cyclopeans, in which they showed how a mutant gene could only be considered in relation to its environment of genes and not as having effect on one character only. To find a similar thesis expounded by experimenters having the annual cotton as their most favourable material is a tribute surely to the immense amount of work done by the geneticists of the Corporation.

The authors make a further significant contribution in that they deal with a cultivated genus, which, like so many others, has long been a puzzle to the systematist; puzzling in its multiplicity of forms which in

the classic systematics is so apt to lead to a multiplicity of names of little help to the practical cotton grower. Here with all the ideas of the "new systematics" made usable through the accumulated genetical and cytological data, the authors are able to produce a simple, straightforward, workable classification without even having to make recourse to the new terms, coenospecies, ecospecies and the like, though they are able to equate their species and varieties to these newer terms.

Gossypium is here defined as including *Ingenhouzia*, *Thurberia*, *Selera*, *Erioxylum* and *Sturtia* and the authors note that "their inclusion in *Gossypium* has been established by genetic and cytological research."

In the chapters of part two and part three much fascinating information regarding the history of cotton as a cultivated crop dating backwards to some 3,000 years B.C. is given and forms almost a chapter on what might be termed the prehistory of Cotton in the Old and New Worlds, for of course these earlier references are based on records other than the written word—sometimes just a fragment of age-old cloth.

Part four, entitled "The Significance of *Gossypium* in Evolutionary Studies" is the part where the valuation of the genetic studies of cotton from the point of view of the general theory of evolution receives its treatment and will be regarded by many as the most valuable contribution made by this work. It is amongst the few attempts yet possible to evaluate the newer theories of cyto-genetics in terms of a genus whose behaviour experimentally has been well worked out. The implications are thoroughly considered and the final paragraph is worth quoting: "All the available evidence supports the view here put forward that the domestication and distribution of crop plants, and the development and conservation of variability within them, are intimately bound up with the origin and spread of civilisation, and that the whole interrelated complex, including civilised man, his domestic animals and his crop plants, have grown from a single root and spread to the New World by trans-pacific migration."

H. B. GILLILAND.

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**OBSERVATIONS ON SOME WATER FUNGI
COLLECTED IN AND AROUND JOHANNESBURG**

By E. P. GOLDSMITH.

(With Plates XV—XVII.)

I. INTRODUCTION.

After a period of relative inactivity, research on aquatic Phycomycetes has shown, during the past 20 years, a remarkable revival. Sparrow (1935) traced this fresh impetus not only to the success of a few stimulating teachers in transmitting to their students their own enthusiasm for these peculiar and obscure organisms, but also to the newly-awakened interest of mycologists and botanists in general in the significance of the lower fungi in interpreting biological phenomena and relationships in other more highly organised groups.

Research done during the past ten years, particularly on the Saprolegniaceae and Pythium, seemed as intensive and productive as that of the decade so ably reviewed by Sparrow (1935), and must, in fact, be regarded as a direct continuation of that phase. From all over the world have come descriptions of new species and records of new localities and new hosts for species already known. New taxonomic treatments for some of the genera have been put forward. Work done in Germany, Australia and Mexico, taken in conjunction with earlier investigations in the United States of America, England, Austria, Latvia and Japan, has indicated a distinct lack of endemism in the distribution of aquatic fungi in the soil. Ivimey-Cook & Morgan (1934) were so impressed by the wide distribution and large variety of Saprolegniaceae in the soil as to suggest that the common name "water moulds" for these fungi should

logically be given up. The cytology of a large number of species has been investigated by various workers. Pathogenic species of *Pythium* have received considerable attention, and it now seems fairly well established that the genus is consistently homothallic.

Raper (1935 *et. seq.*) showed that five hormones were involved in a mutually complementary manner in initiating and co-ordinating the different stages of sexual reaction between the male and female plants of *Achlya ambisexualis*. The same writer (1940) considered that the sexuality of the heterothallic members of the Saprolegniaceae could be explained on a scheme similar to that suggested by Hartmann (1929) and Vandendries (1930). Couch (1941) described dark field studies on the reaction of the cilia of living zoospores of *Saprolegnia ferax*.

Three papers on South African Phycomycetes have been published so far—du Plessis' paper on *Olpidiopsis ricciae* (1933) and Wager's paper on pathogenic species of *Pythium* and *Phytophthora* (1941). Investigating root rot diseases of vegetable and garden plants, the latter found that species of *Pythium* were fairly common and widely-distributed in this country, assigning his isolates to ten known series. Wolf (1941) reported that he isolated *Allomyces arbuscula* from soil samples collected near Balfour, Cape Province, by Miss E. S. Moore who sent them to him.

The present paper is concerned mainly with the identification and description of members of the Saprolegniaceae and species of *Pythium* isolated from eight pools at Frankenwald, the Botanical Research Station of the University of the Witwatersrand, together with records of their occurrence during one calendar year. Samples of water were also collected sporadically from the Zoo Lake and several mine dams along the Witwatersrand.

2. METHODS USED.

From November 1944, to November 1945, samples of water were collected from eight pools at Frankenwald. The samples were taken near the surface, and any twigs, dead insects, etc., seen floating around were included. In each case, at X, A and C two samples were taken, one near the surface and the other from the deepest accessible region. When the pools dried up, samples of mud were collected. Records were kept of the colour and turbidity of the water, presence of algae, change in water level and general appearance of the pools. The samples were brought to the laboratory as soon as possible, where they were uncorked.

The following day, the samples were transferred to shallow dishes and a small amount of tap-water was added. Several sterilised house flies and hemp seed were scattered over the surface to serve as baits. The dishes were kept away from direct sunlight and partly covered with

plate glass to exclude dust while allowing free access to the air. Samples from the Zoo Lake and the mine dams were treated in the same way. Mud samples were placed in petri dishes, tap water was added to a depth of about 1 cm. and baits were set out. The baits were inspected on the 2nd, 4th and 6th days after setting out and records were kept of the species found in each sample.

Pure cultures were obtained by successive transfers, taking advantage of any differences in growth rates and nutritional peculiarities. A bait with a young and vigorous mycelium of the fungus to be identified was selected, and, held with forceps, rotated in a gentle trickle of tap water and placed in a petri dish with fresh baits in sterilised tap water. For species of *Achlya* and *Aphanomyces* a single group of zoospores was drawn up into a pipette made of capillary tubing and placed with fresh baits. If sexual reproduction did not take place when the cultures were reasonably clean, the fungus was grown on a variety of media—including pea decoction, oat-meal agar, corn meal agar, malt agar, malt peptone agar, carrot slices, prune slices, split maize grains and ant pupae—to induce this phase. In general, flies, hemp seeds and maize grains gave the best results, and further details of success are given under the descriptions of the species found. Where the original description was unobtainable in South Africa, identification was based mainly on descriptions given in Coker's monograph on the Saprolegniaceae (1923) and Middleton's monograph on *Pythium* (1943).

3. DESCRIPTIONS OF THE SPECIES.

(1) *Saprolegnia delica* Coker.

Figs. 1, 2, 3. pl. XV.

DESCRIPTION.

Mycelium a dense growth of stout hyphae on house fly baits. *Hyphae* cylindrical, main hyphae sparingly branched. *Sporangia* subcylindrical, of slightly larger diameter than the hyphae on which they arise, primary sporangia terminal on the main hyphae, secondary sporangia formed by repeated proliferation from within the primary, symmetrically and characteristically constricted, rarely arising from below the primary. *Zoospores* discharged in the manner typical for the genus. *Gemmae* spherical, pyriform or clavate, often in chains. *Oogonia* smooth, terminal on short lateral branches or on the main hyphae, typically spherical, wall often with a few inconspicuous pits in addition to those under the antheridia. *Antheridia* typically several per oogonium, declinous more often than monoclinal (*i.e.* obviously arising from the same mycelium

as the oogonium to which it is applied), antheridial cells bulging irregularly, applied along the length to the oogonial wall, antheridial branches of various lengths, frequently long and rambling, the declinuous ones usually arising from hyphae which also bear oogonial branches, fertilisation tubes formed. *Oospores* 1—14, mostly 4—10, in an oogonium, wall thick (*i.e.* more than $1.8\ \mu$ thick), a single reserve globule enclosed in the protoplasm.

Measurements.		Range	Average
		in μ .	in μ .
Diameter of hyphae	.. ..	23—42	34
Length of sporangia	.. ..	88—243	140
Diameter of zoospores	.. ..	10—12	10.5
Diameter of oogonia	.. ..	18—123	64
Diameter of oospores	.. ..	22—29	25

NOTES.

1. This species was isolated from water from Frankenwald, the Zoo Lake and Spaarwater dam and from damp mud from Frankenwald. It was originally described from the United States of America (Coker, 1923) and has been recorded for Europe but not yet for South Africa.

2. The secondary sporangia were symmetrically and gracefully constricted, and proliferation tended to give the effect of a nest of distinctively-shaped tiny vases.

3. The fatty reserve in the oospore invariably took the form of a single large drop which stained the characteristic bright orange colour with Sudan III. This would appear to be most unusual for a species of *Saprolegnia* as, according to Coker (1923), the oospore, throughout the genus, has one or two layers of small fat droplets entirely surrounding the protoplasm.

4. Antheridia and oogonia were readily produced on house fly.

(2) ***Achlya imperfecta*** Coker.

Figs. 4, 5. pl. XV.

DESCRIPTION.

Mycelium a dense growth of stout threads on house fly and hemp seed baits. *Hyphae* tapering gradually towards the tips, main hyphae sparingly branched. *Sporangia* subcylindrical, of slightly larger diameter than the hyphae on which they arise, primary sporangia terminal on the main hyphae, secondary sporangia formed in a closely clustered sympodium by lateral branching from below the primary. *Zoospores* discharged

in the manner typical for the genus. *Gemmae* formed by segmentation of the hyphae behind the sporangia, subcylindrical and in rows. *Oogonia* smooth, terminal on short lateral branches, spherical, wall without pits except under the antheridia, rarely with 1 or 2 inconspicuous ones. *Antheridia* typically several per oogonium, monoclinal more often than declinal, antheridial cells bulging irregularly, applied along the length to the oogonial wall, antheridial branches of various lengths, frequently long and rambling, most commonly arising from hyphae which also bear oogonial branches, sometimes from hyphae which give rise to antheridial branches only, rarely from the oogonial stalks, fertilisation tubes not seen. *Oospores* 3—10, mostly 4 or 5, in an oogonium, often ellipsoidal due to pressure, wall thick, a single reserve globule outside the protoplasm, sometimes disorganising before maturity.

Measurements.	Range in μ .	Average in μ .
Diameter of hyphae	28 — 111	48
Length of sporangia	240 — 502	278
Diameter of zoospores	9 — 12	11
Diameter of oogonia	32.5 — 47	43
Diameter of oospores	18 — 23	20

NOTES.

1. This species was isolated from water from Frankenwald, the Zoo Lake and Spaarwater dam and from damp mud from Frankenwald. It was originally described from the United States of America (Coker, 1923) and has also been recorded for Europe and Japan, but not yet for South Africa.

2. In some cases the reserve globule in the oospore degenerated and in others the oospore as a whole degenerated at an early stage. This was taken as corresponding to Coker's "early dissolution" and "going to pieces before maturity". The majority of the oospores, however, matured normally as did the oospores in *Achlya deBaryana* var. *intermedia* Minden which Coker considered identical with his *A. imperfecta*.

3. Antheridia and oogonia were produced fairly readily on house fly and hemp seed.

4. This species developed best during hot weather.

(3) ***Achlya dubia*** Coker.

Figs. 6, 7, pl. XV, 8. pl. XVI.

DESCRIPTION.

Mycelium a dense growth of stout threads on house fly baits. *Hyphae* tapering gradually towards the tips, main hyphae sparingly branched. *Sporangia* subcylindrical, of slightly larger diameter than the hyphae on which they arise, primary sporangia terminal on main hyphae, secondary sporangia formed sparingly by lateral branching from below the primary. *Zoospores* at first discharged as in *Thraustotheca*, a large mass of protoplasm at the tip of the sporangium sometimes remaining undivided, later as in *Achlya* and occasionally as in *Dictyuchus*. *Gemmae* formed by segmentation of the hyphae behind the sporangia, subcylindrical and in rows. *Oogonia* smooth, terminal on short lateral branches, rarely terminal on the main hyphae, spherical, wall without pits except under the antheridia. *Antheridia* typically several per oogonium, declinuous, antheridial cells applied along the length to the oogonial wall, usually cylindrical and partly encircling the oogonium, antheridial branches of various lengths, most often arising as branches of the main hyphae, sometimes terminating the main hyphae, fertilisation tubes formed. *Oospores* 2—6, frequently 3, in an oogonium, wall thick, a single reserve globule outside the protoplasm.

Measurements.		Range	Average
		in μ .	in μ .
Diameter of hyphae	.. ..	27—93.5	36
Length of sporangia	.. ..	97—336	180
Diameter of zoospores	.. ..	7—12.5	11
Diameter of oogonia	.. ..	39—195	61
Diameter of oospores	.. ..	18—27	20.5

NOTES.

1. This species was isolated from both damp and dry mud from Frankenswald. It was originally described from the United States of America (Coker, 1923), and has been recorded for Europe but not yet for South Africa.

2. Antheridia and oogonia were produced fairly readily on house fly.

(4) *Dictyuchus monosporus* Leitgeb.

Figs. 9, 10. pl. XVI.

DESCRIPTION.

Mycelium a dense growth of stout hyphae on house fly baits and hemp seed baits. *Hyphae* tapering gradually towards the tips, main hyphae sparingly branched. *Sporangia* subcylindrical or clavate, of slightly larger diameter than the hyphae on which they arise, primary sporangia

terminal on the main hyphae, secondary sporangia at first formed in an elongated sympodium, later by segmentation of the hyphae, frequently becoming detached from the hyphae and going into a resting condition in which the vacuoles of the zoospores become conspicuous. *Zoospores* discharged in the manner typical for the genus and leaving a network of persistent walls. *Oogonia* smooth, terminal on lateral branches of various lengths, spherical or subspherical, wall without pits. *Antheridia* 1 or 2 per oogonium, declinous, antheridial cells applied along the length to the oogonial wall, typically cylindrical and partly encircling the oogonium, antheridial branches of various lengths, fertilisation tubes not seen. *Oospores* solitary.

Measurements.		Range	Average
		in μ .	in μ .
Diameter of hyphae ..	..	15—80	45
Length of sporangia ..	..	180—789	320
Diameter of zoospores ..	..	7— 14·5	10·5
Diameter of oogonia ..	..	32— 43	35

NOTES.

1. This species was isolated from water from Frankenwald and Spaarwater Dam and from damp mud from Frankenwald. It was originally described from Europe (Leitgeb, 1869) and also has been recorded for the United States of America and Australia, but not yet for South Africa.

2. Antheridia and oogonia were produced rarely on fly, probably because the male and female strains were present together only on rare occasions.

3. No mature oospores were seen.

4. This species was of somewhat tardy development on the baits.

(5) *Aphanomyces laevis* de Bary.

Figs. 11, 12, pl. XVI.

DESCRIPTION.

Mycelium a dense growth of delicate threads on house fly baits. *Hyphae* cylindrical, sparingly branched. *Sporangia* not differentiated from vegetative hyphae, sometimes sparingly branched, often arising from the substratum. *Zoospores* discharged in the manner typical for the genus. *Oogonia* smooth, terminal typically on short lateral branches, spherical or subspherical, wall without pits. *Antheridia* typically several per oogonium, monoclinal or declinous, antheridial cells bulging irregularly, applied along the length to the oogonial wall, often elongated and wrap-

ping spirally round the oogonium, antheridial branches of various lengths, usually coiling round the oogonial branches in a complicated way, fertilisation tubes formed. *Oospores* solitary, not filling the oogonial cavity, wall thick, a single reserve globule enclosed in the protoplasm.

Measurements.		Range	Average
		in μ .	in μ .
Diameter of hyphae . .	.. ..	4.5—8	6
Diameter of zoospores . .	.. ..	9 —12.5	10
Diameter of oogonia . .	.. ..	24 —32	28
Diameter of oospores . .	.. ..	17 —25	20

NOTES.

1. This species was isolated from water from Frankenwald. It was originally described from Europe (de Bary, 1860) and has also been recorded for the United States of America, but not yet for South Africa.

2. Petersen (1910), Coker (1923) and Couch (1926) all pointed out that this was probably a very variable species, and it was Coker's opinion that the limits of *A. laevis* might be extended to include *A. helicoides* Minden. Cutter (1941), however, considered *A. helicoides* specifically distinct, basing his separation of the two species on the thickness of the oospore wall. Minden (1915) neither mentioned the thickness of the oospore wall nor gave any drawings; but in Cutter's material the oospore wall never reached a thickness greater than 1.5μ . Several investigators have reported that the oospore wall in *A. laevis* measured up to 3μ in thickness. In the Frankenwald fungus the oospore wall attained the latter thickness and, for this reason, according to Cutter, it should be determined as *A. laevis* in spite of the pronounced winding of the antheridial branches. Further points of difference from Minden's fungus were the indiscriminate occurrence of oogonia throughout the mycelium and the absence of any clusters of short intertwined branches forming characteristic knots that might correspond to Minden's "antheridial tangles".

3. Antheridia and oogonia were rarely and apparently capriciously produced on house fly.

4. As Peters (1911) had isolated this species from sugar beets affected by root rot, attempts were made to infect beet and "mangold wurzel" seedlings. These were not successful. Smith (1940) also failed to obtain infection.

(6) **Aphanomyces stellatus** de Bary.

Fig. 13. pl. XVI.

DESCRIPTION.

Mycelium a dense growth of delicate threads on house fly baits. *Hyphae* cylindrical, sparingly branched. *Sporangia* not differentiated from vegetative hyphae, sometimes sparingly branched, often arising from the substratum. *Zoospores* discharged in the manner typical for the genus. *Oogonia* smooth when young, later developing numerous blunt papillae, terminal typically on short lateral branches, subspherical, wall without pits. *Antheridia* typically several per oogonium, monoclinal or dichinous, antheridial cells bulging irregularly, applied along the length to the oogonial wall, antheridial branches of various lengths, fertilisation tubes formed. *Oospores* solitary, not filling the oogonial cavity, wall thin (*i.e.* less than $1.8\ \mu$ thick), numerous reserve droplets in an inconspicuous crescent to one side of the protoplasm.

Measurements.				Range	Average
				in μ .	in μ .
Diameter of hyphae	..	..		3.5—7.5	6
Diameter of zoospores	..	..		7 —10	9
Diameter of oogonia (including papillae)	..	..	..	18 —36	25
Diameter of oospores	..	..		14.5—21.5	20

NOTES.

1. This species was isolated from water from Frankenwald. It was originally described from Europe (de Bary, 1860) and has also been recorded for the United States of America and Japan, but not yet for South Africa.

2. Antheridia and oogonia were rarely and apparently capriciously produced on house fly.

(7) *Pythium dissotocum* Dreschler.

Figs. 14, 15, 16. pl. XVII.

DESCRIPTION.

Mycelium a dense growth of delicate threads on house fly and hemp seed baits. *Hyphae* cylindrical, with short, somewhat swollen dactyloid outgrowths, sparingly branched. *Sporangium* not differentiated from vegetative hyphae, sometimes sparingly branched or including short, somewhat swollen dactyloid outgrowths. *Zoospores* discharged in the manner typical for the genus, 15—24 or more in a vesicle. *Oogonia* smooth, typically terminal, sometimes intercalary, spherical or sub-

spherical. *Antheridia* 1 or 2 per oogonium, monoclinal more often than declinal, antheridial cells crook-shaped in outline, making broad apical contact with the oogonial wall, usually borne on a relatively short branch, occasionally sessile, fertilisation tubes formed. *Oospores* solitary, smooth, almost filling the oogonial cavity, wall thick, a single reserve globule and refringent body enclosed in the protoplasm.

Measurements.			Range	Average
			in μ .	in μ .
Diameter of hyphae	..	..	3.5—7	4
Diameter of zoospores	..	..	7 — 9	8.5
Diameter of oogonia	..	..	16 —36	21
Diameter of oospores	..	..	12.5—32.5	19

NOTES.

1. This species was isolated from water from Frankenwald, the Zoo Lake, Spaarwater Dam and United Roodepoort Dam, and from damp and dry mud from Frankenwald. It was originally described from the United States of America (Dreschler, 1930) and has also been recorded for Japan, but not yet for South Africa.

2. *Antheridia* were rarely and apparently capriciously produced on hemp seed.

3. Some of the strains grew only on house fly and others only on hemp seed, thus indicating a physiological differentiation within the species.

(8) *Pythium perniciosum* Serbinow.

Figs. 17, 18. pl. XVII.

DESCRIPTION.

Mycelium sparse and delicate on hemp seed baits. *Hyphae* cylindrical, frequently swelling out into irregular bulging regions or into catenulate, spherical asexual reproductive bodies of which there are 2—6 in a chain, sparingly branched. *Sporangia* not differentiated from vegetative hyphae, sometimes arising from irregular swollen regions of the hyphae. *Zoospores* discharged in the manner typical for the genus, 15—24 in a vesicle. *Oogonia* smooth, terminal or intercalary, subspherical. *Antheridia* usually 1, occasionally 2 or 3 per oogonium, monoclinal or declinal, antheridial cells slightly curved, making narrow apical contact with the oogonial wall, antheridial branches of various lengths, fertilisation tubes formed. *Oospores* solitary, rarely 2 in an oogonium, smooth, not filling the oogonial cavity, wall thick, a single reserve globule and refringent body enclosed in the protoplasm.

Measurements.	Range in μ .	Average in μ .
Diameter of hyphae	3.5—7	4
Diameter of asexual reproductive bodies	14.5—29	27
Diameter of zoospores	7—11	9
Diameter of oogonia	31.5—36	31
Diameter of oospores	14.5—29	20

NOTES.

1. This species was isolated from water from United Roodepoort Dam. It was originally described from Russia (Serbinow, 1912) and has also been recorded for the United States of America, Europe, the Netherland East Indies, but not yet for South Africa.

2. Antheridia and oogonia were produced fairly readily on hemp seed.

3. As Middleton (1943) had isolated this species from rotted Poinsettia cuttings, attempts were made to infect Poinsettia plants. These were not successful, but the fungus was grown in water cultures on pieces of Poinsettia stem.

(9) **Pythium polytulum** Dreschler.

Figs. 19, 20, 21. pl. XVII.

DESCRIPTION.

Mycelium a dense growth of delicate threads on house fly and hemp seed baits. *Hyphae* cylindrical, sparingly branched. *Sporangia* spherical or subspherical, resting sporangia papillate, arising terminally though sometimes assuming a lateral position due to resumption of growth by the supporting hypha, proliferous. *Zoospores* discharged in the manner typical for the genus, 9—23 in a vesicle. *Oogonia* smooth, typically terminal, sometimes intercalary or lateral, subspherical, often protruding irregularly towards the antheridia. *Antheridia* 1—5, mostly 1—3, per oogonium, typically declinous, occasionally monoclinal, antheridial cells often elongated and irregularly wavy in outline, applied along the length to the oogonial wall, sessile or borne on branches of various lengths, on a comparatively long branch when monoclinal, fertilisation tube arising from the centre of the region applied to the oogonium. *Oospores* solitary, smooth, not filling the oogonial cavity, wall thick, 3—12 reserve globules and several refringent bodies enclosed in the protoplasm.

Measurements.		Range in μ .	Average in μ .
Diameter of hyphae	.. ..	2 — 7	4
Diameter of sporangia	.. ..	21.5—30	28
Diameter of zoospores	.. ..	8 —10	9
Diameter of oogonia	.. ..	30 —43	34
Diameter of oospores	.. ..	21.5—32.5	28

NOTES.

1. This species was isolated from water from Frankenwald, the Zoo Lake and Spaarwater Dam, and from damp mud from Frankenwald. It was originally described from the United States of America (Dreschler, 1930) and has not been recorded for any other country.

2. Antheridia and oogonia were produced fairly readily on split maize grain.

(10) *Pythium ultimum* Trow.

Fig. 22. pl. XVII.

DESCRIPTION.

Mycelium a dense growth of delicate threads on house fly and hemp seed baits. *Hyphae* cylindrical, much branched. *Sporangia* spherical or subspherical, terminal or lateral, rarely intercalary, germinating by germ tubes or developing a single conspicuous vacuole, enlarging and assuming irregular shapes. *Oogonia* smooth, terminal, rarely intercalary, spherical. *Antheridia* typically 1 per oogonium and monoclinal from just next to it, occasionally 2 in which case one may be declinal, antheridial cells sometimes not delimited by a septum, when monoclinal sharply curved to make narrow apical contact with an adjacent part of the oogonial wall, when declinal straight, antheridial branches short, fertilisation tubes formed. *Oospores* solitary, smooth, not filling the oogonial cavity, wall thick.

Measurements.		Range in μ .	Average in μ .
Diameter of hyphae	.. ..	2 — 7	4
Diameter of sporangia	.. ..	14 —32	24
Diameter of oogonia	.. ..	21.5—25	23
Diameter of oospores	.. ..	18 —23	19.5

NOTES.

1. This species was isolated from dry mud at Frankenwald. It was originally described from Europe (Trow, 1901) and has been recorded for the United States of America, Canada, the Philippine Islands, Australia,

New Zealand, Rhodesia and South Africa. It was described and figured for South Africa by Wager (1941) who isolated it from a large number of hosts and investigated its temperature growth relations.

2. Antheridia and oogonia were produced fairly readily on split maize grain.

3. No reserve globules were seen in the oospores.

(11) *Allomyces* sp.

Figs. 23, 24, 25. pl. XVII.

DESCRIPTION.

Mycelium a dense growth of stout threads on house fly and hemp seed baits. *Hyphae* tapering gradually towards the tips, divided into segments by pseudosepta which are perforated in the early stages, sparingly branched. *Sporangia* oval, typically in short chains at the ends of the hyphae, also solitary and arising terminally though often assuming a lateral position due to resumption of growth by the supporting hypha opening by 1 or 2 exit pores. *Zoospores* discharged singly. *Resting bodies* resembling the sporangia in shape and intermingled indiscriminately with them, wall thick and pitted, eventually lying free in the sheath formed by the cell wall and slipping out. *Gametangia* not observed.

Measurements.		Range	Average
		in μ .	in μ .
Diameter of hyphae	.. ..	11— 38	17
Length between pseudosepta	.. ..	20—402	210
Length of sporangia	.. ..	40— 58	48
Diameter of sporangia	.. ..	24— 36	26
Diameter of zoospores	.. ..	7— 11	9.5
Length of resting bodies	.. ..	36— 52	46
Diameter of resting bodies	.. ..	25— 34	28

NOTES.

1. This species was isolated from damp and dry mud from Frankenburg.

4. SEASONAL DISTRIBUTION.

As a contribution to our knowledge of the seasonal distribution of the species found, the frequency of their occurrence was worked out on a percentage basis (see Table I, p. 149). A single record is given for both species of *Aphanomyces*, as it was difficult to distinguish between them on account of the similarity of the sporangia and of the rare and apparently

capricious production of antheridia and oogonia. Although no definite conclusions can be drawn from the results, they give some indication of the relative abundance with which the species tended to occur at different seasons.

The largest number of different species was found in the spring, during a severe drought. *Achlya dubia*, *Pythium ultimum* and *Allomyces* sp. were isolated only from mud samples collected in the spring. Without further investigation, it would be impossible to decide whether the appearance of these forms was influenced by the season or the weather, or whether their habitat was restricted to the mud at the bottom of the pools and did not extend to the water. There was a marked decline in the abundance of *Saprolegnia delica*, *Pythium dissotocum* and *Pythium polytylum* in the summer. *Dictyuchus monosporus*, on the other hand, was not found at all during the winter. *Aphanomyces* spp. decreased in abundance in the winter and a further decrease took place in the spring, which might be taken to indicate an adverse effect of drought on these species. *Pythium* sp. made its appearance only after the intense cold of the winter. *Achlya imperfecta* was present in about the same percentage of samples in all four seasons but, as previously noted, it developed best during hot weather.

Saprolegnia delica was the most abundant species in all the samples, both occurring with the greatest frequency and producing the largest number of mycelia. *Pythium dissotocum* and *Pythium polytylum* were clearly equal in abundance to some of the Saprolegniaceae.

5. WEATHER FOR THE YEAR.

At times, during the period of collecting, the weather reached extremes for our climate. December was exceptionally dry and the rainfall for March was unusually high. There was snow in May and extremely low temperatures were reached in June. Very little rain fell in the spring.

6. THE POOLS AT FRANKENWALD.

A preliminary inspection of the water-holes and water-courses at Frankenwald was undertaken and 8 pools, which seemed representative of the area, were chosen to collect from. Underlying the whole region is the old granite of the Witwatersrand system in which quartz crush zones and diabase dykes are common. The presence of the pools is due to the occurrence of either of the latter geological formations—Pools X, L, A, and R to quartz crush zones and B, C and N to diabase dykes, which in the case of B and C cross under the Jukskei River. The Jukskei arises within the municipal area of Johannesburg and makes its way to

TABLE I.
SEASONAL DISTRIBUTION.

Species.	November.	December.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	Summer.	Autumn.	Winter.	Spring.	All Samples.
<i>Saprolegnia delica</i> ..	53	52	44	50	77	62	86	82	81	95	72	67	49	74	85	69	66.4
<i>Achlya imperfecta</i> ..	58	40	18	45	35	38	27	18	24	45	39	33	37	34	35	36	34.7
<i>Achlya dubia</i> ..	..	..	..	..	..	..	..	..	..	..	6	6	..	..	..	6	0.8
<i>Dictyuchus monosporus</i> ..	..	8	6	32	19	8	..	..	..	..	6	33	11	9	..	19	9.4
Aphanomyces (2 species)	79	72	73	91	58	69	55	18	52	20	22	28	78	61	32	25	56.8
<i>Pythium dissotocum</i> ..	..	16	29	36	50	62	41	36	57	60	44	39	22	51	53	42	39.3
<i>Pythium perniciosum</i> ..	..	4	..	..	..	..	..	..	..	..	..	..	1	..	..	..	0.4
<i>Pythium polytylum</i> ..	..	4	18	41	38	58	45	18	33	50	33	39	16	47	36	36	31.7
<i>Pythium ultimum</i> ..	..	..	..	..	..	..	..	..	..	..	6	11	..	..	..	8	1.1
Water mould with resting bodies ..	..	..	..	..	4	..	..	..	..	..	..	..	..	1	..	..	0.4
<i>Pythium</i> sp. ..	..	..	..	..	..	..	5	..	10	10	11	6	..	1	8	8	3.1
<i>Pythium</i> sp. ..	..	..	..	..	..	..	..	..	..	..	6	6	..	..	..	6	0.8
<i>Allomyces</i> sp. ..	..	..	..	..	..	..	..	..	..	..	6	6	..	..	..	6	0.8
Number of species ..	19	25	34	22	26	26	22	11	21	20	18	18	100	74	52	36	262

Alexandra, a native township, and then through Frankenwald. B, L, N, R and S were never more than 2 ft. deep and X, A and C were usually 2—3 ft. deep. Except for some sedges at C, very little decaying material was found floating on the surface of the water. S was the only pool in which any movement was discernable. Apart from N, which was protected by a large overhanging willow, the pools were not in any way shaded. Glover (1937) described the species of flowering plants to be found round the pools and along the river. The surrounding soil is poor in terms of food values. Geese were kept at N. At times, cattle, sheep and donkeys had access to X, A, B, C and S, and the native farm labourers used the water of the same pools indiscriminately for all purposes.

Pool X.

The water was usually a dark, muddy brown and algae were rarely present. In the summer, there was a considerable drop in level but only during the spring drought did the pool dry up altogether, revealing rusty kitchen utensils, old boots and other rubbish in the mud. The western end of the pool was dammed-up with dead slangbos plants. The species of fungi found near the surface were the same as those found at a lower level, viz., *Saprolegnia delicata*, *Achlya imperfecta*, *Aphanomyces* sp., *Pythium dissotocum* and *Pythium polytylum*. *Achlya dubia*, *Pythium ultimum* and *Allomyces* sp. were isolated from the mud in the spring.

Pool A.

The water was usually an opaque, brownish grey and algae were occasionally present. The water level dropped considerably in the dry weather, but the pool did not dry up altogether during the time of collecting. For some weeks after the autumn rains, a considerable area surrounding the pool was marshy. The species of fungi found near the surface were the same as those found at a lower level, viz., *Saprolegnia delicata*, *Achlya imperfecta*, *Pythium dissotocum*, *Pythium polytylum*, and rarely *Dictyuchus monosporus*.

Pools B and C.

Although B and C are so close together, the water at C was often of a different colour and turbidity from that at B. At B it was always grey but at C it varied from bluish-grey to light brown, and at both pools the water varied from translucent to opaque. These differences may have been due to differences in the surrounding soil. Algae were usually present in both pools, frequently forming a fine scum at B and filamentous species growing attached to the decaying sedges on the surface at C. The water level at C varied far more than at B but neither of the pools dried up altogether during the time of collecting. The same species of fungi

were found at B and at C both near the surface and at a lower level, viz., *Saprolegnia delica*, *Achlya imperfecta*, *Dictyuchus monosporus*, *Aphanomyces stellatus*, *Pythium dissotocum* and *Pythium polytylum*.

Pool L.

The water was always clear and no algae were ever seen. The spring itself was walled off and covered over, and the pool formed by the water seeping through a crack in the wall and from which samples were taken dried up altogether several times during the summer and the spring. The fungi found were *Saprolegnia delica*, *Achlya imperfecta*, *Dictyuchus monosporus*, *Aphanomyces sp.*, *Pythium dissotocum* and *Pythium polytylum*. The strain of *Saprolegnia delica* in this pool was most prolific.

Pool N.

The water was usually a dark, brownish grey and varied from clear to opaque. Algae were often present. The water level dropped considerably in the dry weather, but the pool did not dry up altogether during the time of collecting. The fungi found were *Saprolegnia delica*, *Achlya imperfecta*, *Dictyuchus monosporus*, *Aphanomyces laevis*, *Pythium dissotocum* and *Pythium polytylum*.

Pool R.

The water was nearly always opaque and it varied a good deal in colour, changing from bluish-grey to brown and yellowish-green. Algae were sometimes present, forming a thick scum. The pool dried up altogether for several weeks during the summer and again for a shorter time during the spring. The fungi found were *Saprolegnia delica*, *Achlya imperfecta*, *Dictyuchus monosporus*, *Aphanomyces sp.*, *Pythium dissotocum* and *Pythium polytylum*. *Achlya dubia* was isolated from the mud in the spring.

Pool S.

Samples were taken from a quiet pool among the rocks along the east bank of the river. The water was usually clear, except after storms, when it was brown with silt. Algae were rarely present. There were only slight changes in the water level, and the pool did not dry up altogether during the time of collecting. The fungi found were *Saprolegnia delica*, *Achlya imperfecta*, *Dictyuchus monosporus*, *Aphanomyces sp.*, *Pythium dissotocum* and *Pythium polytylum*.

The results of a bacterial analysis of water samples taken after prolonged heavy rains are as follows :—

Innumerable organisms per ml. growing at 37°C. *Bacillus coli* present in 1 ml., not isolated from 0.1 ml. in pools X, A and B.

Seventy-four organisms per ml. growing at 37°C. *B. coli* not isolated from 10 ml. in pool C.

Innumerable organisms present in pools L and N, per ml. growing at 37°C. *B. coli* present in 10 ml., not isolated from 1 ml.

Pool R.—Innumerable organisms present per ml. growing at 37°C. *B. coli* present in 1 ml., not isolated from 0.1 ml.

Pool S.—Innumerable organisms per ml. growing at 37°C. *B. coli* present in 0.1 ml.

The results of a chemical analysis of water samples are given in table II p. 152. Except where stated, the samples were taken after prolonged heavy rains.

7. DISCUSSION.

This investigation agrees with the findings of Maurizio (1896), that the water moulds are small fungi with an obvious mycelium able to live saprophytically. With only one exception, the samples as collected did not contain any mycelia but, in spite of this, whitish hyphae would soon appear on suitable baits.

To determine the genus of one of these fungi the discharge of zoospores must be observed, while to determine the species sexual reproduction must be observed, so that it is necessary to follow the complete life cycle for purposes of identification. This is sometimes a task for which time and patience are needed because, as Cotner (1930) showed, each species requires a certain definite set of conditions for the formation of typical zoospores, and many workers have found that the nutritional requirements for sexual reproduction are exacting and differ with each species. Although the fish parasite, *Saprolegnia parasitica*, has been studied more than any other member of the Saprolegniaceae, it was considered sterile for over 60 years. Kanouse (1932) inferred that there were physiological strains within the species, as some isolates reproduced sexually on a given medium while others did not, although identical stimuli were present. Numerous collections and cultures of *Dictyuchus monosporus* were made by Coker and his students; but only after 15 years did they obtain antheridia and oogonia, and then the genus was shown to be heterothallic (Couch, 1926). It was some years before Wager (1941) obtained any oogonia of *Pythium splendens*. Eventually, he discovered about a dozen in a three months' old culture, but the contents remained undifferentiated and oospores were not produced. Moreover, as is well-known, water moulds are very susceptible to changes of en-

vironment, and such changes may lead to variation even in those characters which have been regarded as constant and of value in classification. While the presence of forms intermediate between species and even between genera is, as Ivimey-Cook and Morgan (1934) indicate, of considerable interest from an evolutionary standpoint, it makes the taxonomic treatment correspondingly difficult.

The observations made in this investigation contribute no more than a mere fragment to our picture of the phycomycetous flora of this country. Little is known of the occurrence, periodicity and environmental factors influencing the growth of these fungi and, in all probability, many more species are to be found in and around Johannesburg. The recording for South Africa of the species described in this paper is of significance in emphasising the absence of endemism in their distribution.

Ordinarily, the presence of nitrogenous compounds such as nitrates, nitrites and ammonia in the pools would be regarded as evidence of organic pollution, but, in this instance their presence is more likely to be an indication of drainage of fertilisers from the pasture research plots. These substances could not have been without effect on the variety of the water moulds found and on their nutrition. The presence of *Bacillus coli* is evidence of organic contamination which would make the water unsafe for drinking. Certain fungi were isolated from all the pools at some stage during the time of collecting, viz., *Saprolegnia delica*, *Achlya imperfecta*, *Dictyuchus monosporus* (from all except X), *Aphanomyces* sp., *Pythium dissotocum* and *Pythium polytylum*. It is suggested that the strain of *Saprolegnia delica* at L might be suitable for the cytological investigation of sexual reproduction in this species as antheridia and oogonia were readily and abundantly produced, and that *Pythium* sp. might be suitable for studying the cytology of zoospore formation in this genus on account of the large size of the zoospores. Information on both these subjects, is, at present, lacking.

8. SUMMARY.

Fourteen species of water fungi were isolated and ten of them were identified as being already known species. Of the remaining forms the material obtained was not good enough for determination. Nine species were recorded, described and figured for South Africa for the first time, viz., *Saprolegnia delica*, *Achlya imperfecta*, *Achlya dubia*, *Dictyuchus monosporus*, *Aphanomyces laevis*, *Aphanomyces stellatus*, *Pythium dissotocum*, *Pythium perniciosum* and *Pythium polytylum*. A report of the occurrence of these species in this country emphasises the absence of endemism in their distribution. The seasonal distribution of the species found was worked out on a percentage basis for one calendar year. *Achlya*

dubia, *Pythium ultimum* and *Allomyces* sp. were isolated only from mud in the spring.

The species most commonly found at Frankenwald included *Saprolegnia delica*, *Achlya imperfecta*, *Dictyuchus monosporus*, *Aphanomyces laevis*, *Aphanomyces stellatus*, *Pythium dissotocum*, and *Pythium polytylum*. A chemical analysis of the water indicated that fertilisers from nearby pasture research plots were draining into the pools. A bacterial analysis showed that the water was unsafe for drinking.

9. ACKNOWLEDGMENTS.

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II. EXPLANATION OF PLATES.

Figs. 1, 2, 4, 6, 8, 9 and 23 are drawn with the magnification 75 $\times$.

Figs. 3, 5, 7, 10-22, 24 and 25 are drawn with the magnification 250 $\times$.

- FIG. 1. *Saprolegnia delica*. Antheridia and oogonia.
- FIG. 2. *Saprolegnia delica*. (a) sporangium.
(b) chain of gemmae.
- FIG. 3. *Saprolegnia delica*. (a) young oogonium with monoclinal and diclinal antheridia.
(b) antheridia and oogonia showing fertilisation tube approaching oospore.
(c) oogonium with mature oospores.
- FIG. 4. *Achlya imperfecta*. Antheridia and oogonia.
- FIG. 5. *Achlya imperfecta*. Oogonium with pits and one disorganising oospore.
- FIG. 6. *Achlya dubia*. Sporangia.
- FIG. 7. *Achlya dubia*. Oogonia with antheridia.
- FIG. 8. *Achlya dubia*. Chain of empty gemmae, antheridia and oogonia.
- FIG. 9. *Dictyuchus monosporus*. Antheridia and oogonia.
- FIG. 10. *Dictyuchus monosporus*. Antheridia and oogonia.
- FIG. 11. *Aphanomyces laevis*. (a) and (b) antheridia winding spirally round young oogonia.
(c) oogonium with mature oospore.
- FIG. 12. *Aphanomyces laevis*. (a) oogonium and coiling antheridial branches.
(b) antheridia, oogonium fertilisation tube.
- FIG. 13. *Aphanomyces stellatus*. (a) oogonium with diclinal antheridium.
(b) oogonium with mature oospore.
(c) oogonium with monoclinal antheridium.
- FIG. 14. *Pythium dissotocum*. Sporangia.
- FIG. 15. *Pythium dissotocum*. (a) hypha with outgrowths.
(b) intercalary oogonium with diclinal oospore.
- FIG. 16. *Pythium dissotocum*. (a) and (b) terminal oogonia with diclinal antheridia.
(c) oogonium with one monoclinal and one diclinal antheridium.
(d) oogonium with sessile antheridium.
- FIG. 17. *Pythium perniciosum*. (a) sporangium and irregular swollen region of hypha.
(b) sporangium and chain of asexual reproductive bodies.
- FIG. 18. *Pythium perniciosum*. (a) and (d) terminal oogonia with diclinal antheridia.
(b) oogonium with two antheridia.
(c) young oogonium with 3 monoclinal antheridia.
- FIG. 19. *Pythium polytylum*. Sporangia.
- FIG. 20. *Pythium polytylum*. (a) lateral oogonium with diclinal antheridium.
(b) intercalary oogonium with diclinal antheridia.
(c) terminal oogonium with sessile antheridium.
(d) terminal oogonium with mature oospore.
- FIG. 21. *Pythium polytylum*. Oogonium with 1 monoclinal and 2 diclinal antheridia.

- FIG. 22. *Pythium ultimum*. (a) terminal oogonium with monoclinal antheridium and mature oospore.
(b) terminal oogonium with monoclinal and diclinal antheridia.
(c) intercalary oogonium with monoclinal antheridium.
(d) intercalary oogonium with 2 monoclinal antheridia.
- FIG. 23. *Allomyces* sp. Sporangia with resting bodies.
- FIG. 24. *Allomyces* sp. Hyphae showing perforated pseudosepta.
- FIG. 25. *Allomyces* sp. (a) sporangium with escaping zoospores.
(b) chain of empty sporangia and resting body.

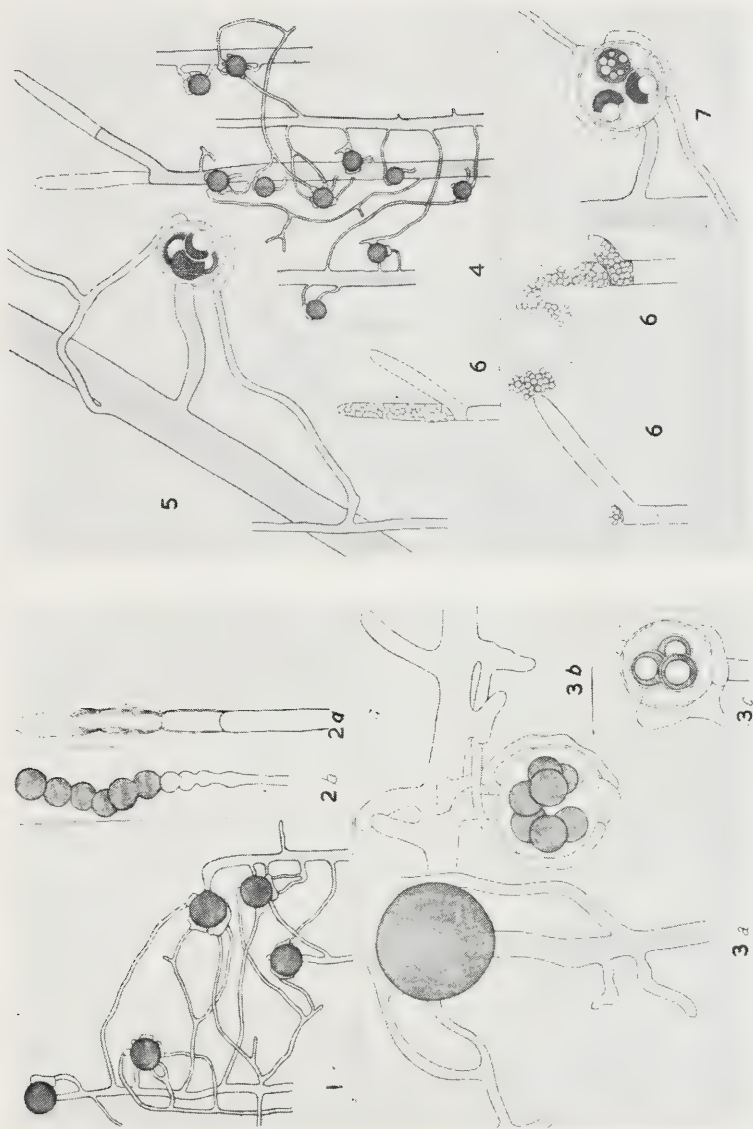


PLATE XV.

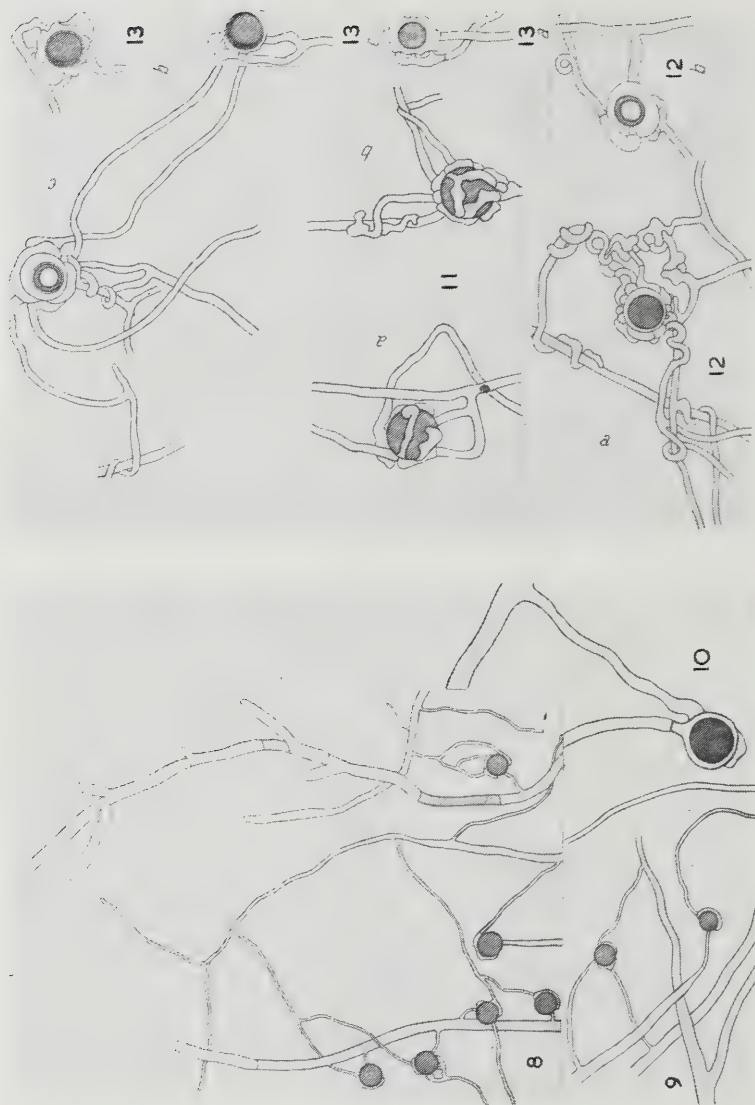


PLATE XVI.

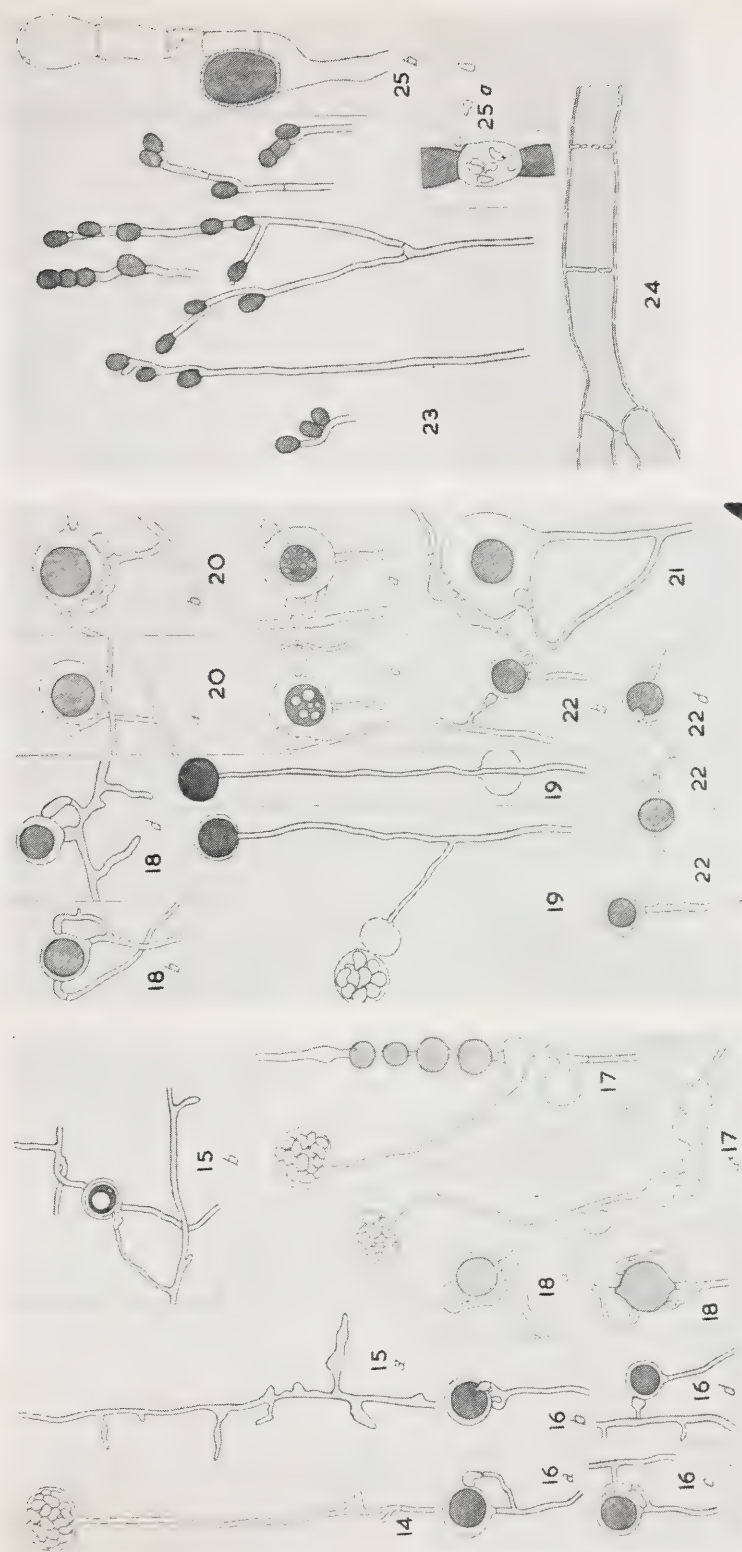


PLATE XVII.

THE DEVELOPMENT OF THE OVULE AND THE SEED IN THE HYPOXIDEAE.

PART I.

IANTHE SALISB.

By MIRIAM P. DE VOS.

This investigation was undertaken to compare the development of the ovule and the seed in the genus *Ianthe* (*Hypoxis* L.) with that in *Pauridia* Harv. After the work was under way, Stenar's publication (1925) on the embryology of two species of *Hypoxis* was received. It became evident that in *Ianthe aquatica* the formation of the endosperm differs from that in the species investigated by Stenar, and it was therefore considered necessary to examine more species of *Ianthe* to determine the type of endosperm development in other South African representatives of the genus.

Method.—The plants were collected on the Stellenbosch Flats. Ovaries in different stages of development were fixed in the FAA fixative and after embedding were cut 8 to 12 μ in thickness and treated either with Heidenhain's iron-alum haematoxylin or with Delafield's haematoxylin, the former to show the nucleus and cell divisions, and the latter to show up the cell-walls. Microchemical tests were made to determine the character of the cell-walls. As tests for reserve food-materials in the endosperm had already been made (Markötter, 1936), they were not repeated.

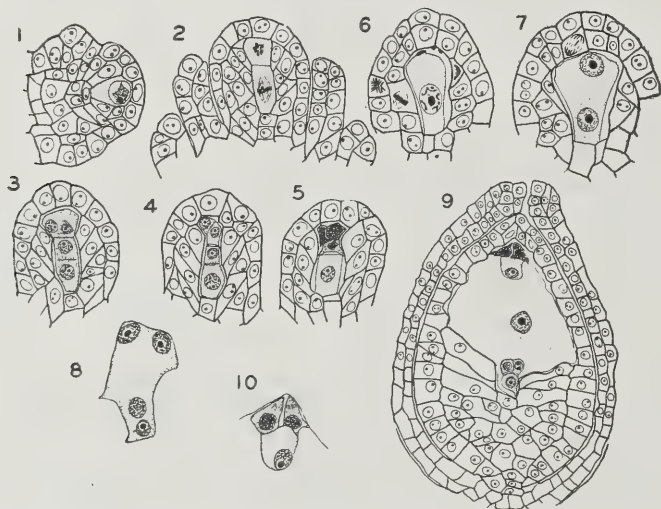
Ianthe aquatica (L.f.) Williams.

The anatropous ovules possess two integuments and are arranged in two rows in axile placentations.

Gametogenesis.—The single-celled archesporium is hypodermal in origin and functions directly as a megaspore mother-cell. It enlarges considerably before undergoing reduction division. In the first meiotic division the spindle lies parallel to the longitudinal axis of the ovule, and during the interphase a cell-wall is formed between the two daughter nuclei. In the second reduction division the spindle in the lower cell again lies parallel to the longitudinal axis, but the one in the upper cell is placed more or less at right angles to it. After this division two other

cell-walls are laid down in such a way that the four megaspores show a T-shaped arrangement. Sometimes they are in a nearly linear position, the upper one, however, being slightly out of the straight line.

Sometimes two megaspore mother-cells lying next to each other are formed in one ovule, and in one case it was found that one of these mother-cells had degenerated. A few ovules contained two perfectly normal embryo-sacs separated from each other by a layer of nucellar cells, and this shows that two megaspore mother-cells can develop in one ovule.



FIGS. 1—10. Formation of megagametophyte in *Ianthe aquatica*. 1. Megaspore mother-cell; 2. Second reduction division of the megaspore mother-cell; 3. Cytokinesis after the second reduction division; 4. Four megaspores; 5. Functioning megaspore, with the others degenerating; 6. Functioning megaspore enlarging, the other megaspores having been absorbed; the nucellus has divided to form two cell layers above the megaspore; 7. Young embryo-sac with two nuclei; 8. Young embryo-sac with four nuclei; 9. Mature embryo-sac; the outer integument is not shown; 10. Egg-apparatus of the embryo-sac, showing the filiform apparatus of the synergids.

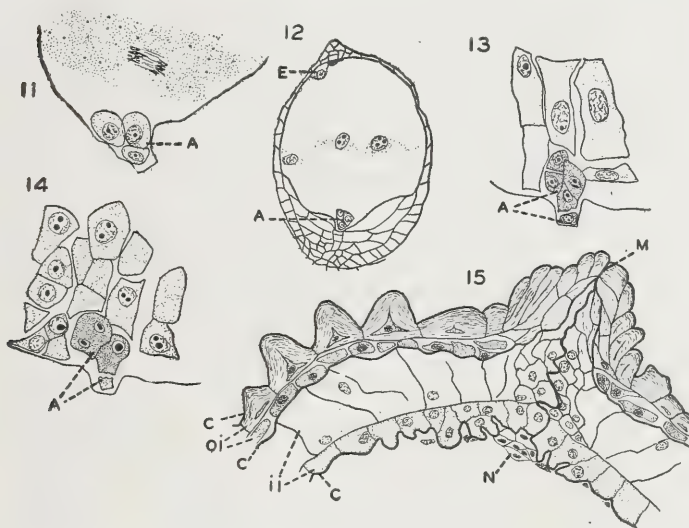
FIGS. 1—8 and 10 $\times 450$; FIG. 9 $\times 300$.

The nucellus is small. At the micropylar end the megaspores are covered only by the epidermis of the nucellus, but when the functioning megaspore enlarges, a few of these epidermal cells divide by periclinal walls to form a two-layered nucellar cap.

After three nuclear divisions the megaspore at the chalazal end develops into a normal eight-nucleate embryo-sac, while the other megaspores degenerate and are absorbed. The basal end of the embryo-sac

remains narrow, but the upper part widens considerably after it has absorbed some of the nucellar cells along its sides. Here the embryo-sac is covered only by the nucellar epidermis, which is very rich in protoplasmic contents and differs in this respect from all other cells in the ovule. At the base of the embryo-sac the nucellus is pluri-layered.

The embryo-sac has three antipodal cells crowded into the narrow basal end, and at the opposite end an egg-apparatus consisting of the egg-cell and the two synergids. The latter show a "filiform apparatus" in



FIGS. 11—15. Formation of endosperm and testa in *Ianthe aquatica*. 11. First division of the primary endosperm nucleus; A. Antipodal cells; 12. Embryo-sac with a few free endosperm nuclei; E. Fertilised egg-cell; 13. Persistent antipodal cells, two having undergone cell division; endosperm cells not yet filling the embryo-sac cavity; 14. Persistent antipodals, one with two nuclei, in older endosperm tissue; 15. Nearly mature testa; C. Cuticle; II. Inner integument; OI. Outer integument; M. Old micropyle; N. Nucellar cap. Fig. 11 $\times 450$; Fig. 12 $\times 150$; Figs. 13—15 $\times 300$.

their pointed ends. Before the flower opens the two polar nuclei fuse to form the secondary nucleus, which lies in the centre of the embryo-sac, attached to its sides by strands of protoplasm.

Fertilisation and Endosperm.—The pollen tube enters through the micropyle, and soon after fertilisation has taken place, the primary endosperm nucleus begins to divide. The spindle of the first nuclear division is in a transverse position. By repeated divisions large numbers (200 to

300 nuclei were counted) of free nuclei are formed, which are arranged in a single layer within a band of cytoplasm along the walls of the embryo-sac. The centre of the sac is filled with cell-sap.

After the young embryo has reached the 32-celled stage, cell-walls are laid down between all the endosperm nuclei, thus forming a layer of cells, which increase in number by repeated cell divisions and later completely fill the embryo-sac with endosperm tissue.

No basal cell is cut off from the primary endosperm nucleus, as Stenar found in *Hypoxis decumbens* (1925).

In a large number of ovules, especially those in the base of the ovary, hypertrophy of the endosperm nuclei occurs before the cell-walls are formed. Such embryo-sacs contain a small number of large lobed nuclei with large nucleoli and chromatin lumps. Some of these nuclei are 120 by 20 μ in size, and a few were seen to divide by multipolar spindles. The embryo in such ovules begins to develop, but later has a shrunken appearance, and these ovules probably degenerate.

The Antipodal Cells.—The antipodals undergo a varying fate. In a number of ovules they degenerate soon after the fertilisation. In most cases, however, they live for some time after the fertilisation and may even persist until the endosperm fills the embryo-sac completely. One or two of them may increase in size, and in a small number of cases the nucleus divides, and this may be followed by a division of the cell.

Due to the well-developed integuments, a very narrow chalazal passage is left through which the nutritive material has to pass to the embryo-sac, and some greyish droplets visible in the base of the endosperm cavity indicate that materials enter the embryo-sac through this passage.

The Embryo.—After the primary endosperm nucleus has formed a number of nuclei, the fertilised egg-cell, hanging from the nucellar cap into the cavity of the embryo-sac, begins to divide. The first division is by a transverse wall into an apical and a basal cell, *ca* and *cb*. The apical cell divides by a longitudinal wall slightly before the division of the basal cell, which divides by a transverse wall into *m* and *ci*. This is the quadrant stage.

The new basal cell *ci* again divides by a transverse wall into *n* and *n'*, the two cells of *ca* divide by another longitudinal wall at right angles to the first to form four cells, and in the middle cell *m* a longitudinal wall is laid down. In this way the octant stage is reached, *ca* and *cb* each having contributed four cells.

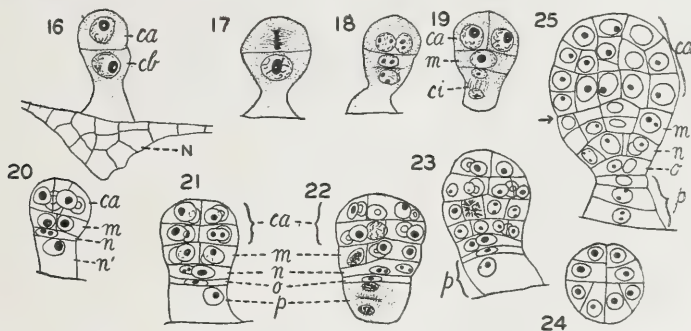
The basal cell *n'* divides by a transverse wall into *o* and *p*, *n* by a longitudinal wall into two cells, the four cells of *ca* by transverse walls to form two layers of four cells each, and the two cells of *m* by longitudinal

walls to form four cells. This gives the 16-celled stage to which *ca* and *cb* each contribute eight cells.

The new basal cell *p* divides by a transverse wall, both layers of cells of *ca* and the four cells of *m* by longitudinal walls into eight cells each, the two cells of *n* by longitudinal walls into four cells, and the cell *o* similarly into two cells. Thus the 32-celled stage is reached, 16 cells having originated from *ca* and 16 from *cb*.

(The cell divisions which bring the embryo from one stage to the next, do not take place simultaneously, nor in the order enumerated in each paragraph.)

The next cell divisions in the region of *ca* are more or less irregular. The dermatogen now becomes visible for the first time, but no perilem or plerome is differentiated. The embryo is formed not only from the apical cell of the two-celled pro-embryo, but the basal cell also contributes to its structure. The cells derived from *ca* form only the terminal cotyledon, and the hypocotyl and the radicle are formed by the layers *m*, *n* and *o*, derived from the basal cell. The suspensor is derived only from the cell *p*, which divides a few times by transverse walls to form a short row of cells.



FIGS. 16—25. Formation of embryo in *Ianthé aquatica*. 16. Two-celled pro-embryo; N, Nucellar cap; 17. Division of the apical cell, nucleus of the basal cell in prophase; 18. Cytokinesis before the quadrant stage; 19. Division of the basal cell *ci* into *n* and *n'*; 20. Octant stage; 21. Sixteen-celled stage; 22. 23. Some cell divisions to form the 32-celled stage; 24. Transverse section of 32-celled embryo, showing the second layer of *ca* with eight cells; 25. Undifferentiated embryo of nearly ripe seed; *p*, suspensor; *ca* will form the terminal cotyledon; position of growing point of plumule indicated by arrow. $\times 450$.

The future growing point of the plumule is indicated on one side of the embryo by a small indentation where the cells in the dermatogen and adjacent layers divide faster than on the other side. Except for this slight indentation, the embryo of the mature seed is undifferentiated, and

Markötter, who investigated the germination, found that the seed has to undergo a long after-ripening process while lying on the ground during the winter. The embryo lies embedded in the endosperm and is attached to the small nucellar cap by means of a short suspensor.

The Integuments and Testa.—The integuments begin to develop before the megaspore mother-cell undergoes reduction division, and at the time of fertilisation they enclose the nucellus completely. The outer integument is not reduced near the funiculus. The micropylar canal is formed by both integuments, but the endostome is longer than the exostome. Each integument consists of two layers of cells, except at their extreme tips, where they are three-layered. Their surfaces as well as that of the nucellus are covered by a thin cuticle which hardly thickens in the ripening seed.

The testa of the ripe seed is formed by the two integuments, both of which largely remain two-layered. Here and there a few cells of the second layer of the outer integument divide by periclinal walls. At the chalaza and along the raphe, however, the seed-coat consists of more than four layers of cells.

The Outer Integument.—An outgrowth is produced from the external wall of each cell of the outer layer, giving the testa a warty appearance. This outer cell-wall becomes thickened to such an extent that the lumina of the cells are completely obliterated. Schultz's solution shows it to consist of cellulose. No lignin or suberin is present, but later this layer turns yellow and then black due to the impregnation of the cellulose layers with some other substance. The outer cuticle covering this layer is only slightly thickened.

In the nearly ripe seed the second layer of cells is still rich in protoplasmic contents and the nuclei are visible. The cells are flat and remain thin-walled and contain some starch grains. The cuticles separating the two integuments fuse to form one layer.

The Inner Integument.—The cells of the outer layer enlarge considerably and are very poor in protoplasmic contents. A few nuclei are still visible when the seed is nearly ripe, but later these cells disintegrate by the breaking-down of some of the anticlinal walls. This layer probably becomes filled with air, and in the ripe seed it is compressed to a small part of its former width, due to the pressure exerted by the developing endosperm. In the nearly ripe seed the inner layer of cells still retains its protoplasmic contents, and the cells are large but flat, except at the micropyle where they are quite small. The nucellar cuticle fuses with that on the inner surface of this integument, and in the micropylar region deep folds are observed in it. The old endostome canal is likewise lined with a deeply-folded cuticle.

The Nucellus is completely absorbed except for the cuticle, a few cells at the base and the small nucellar cap at the micropyle.

Ianthe alba (L.f.) Salisb., **I. minuta** (L.f.) Williams and **I. Schlechteri** (Bol.) Williams.

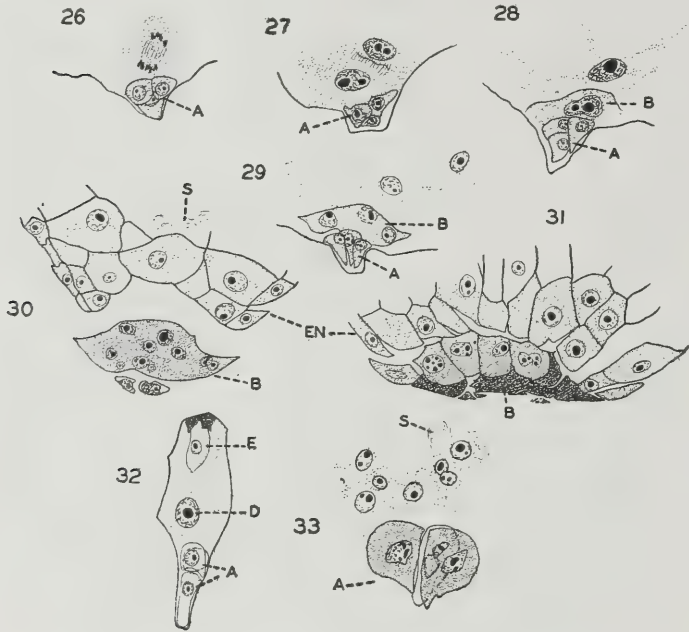
Gametogenesis.—The structure of the ovule and the development of the female gametophyte in these species are identical with that of *I. aquatica*. The ovules are anatropous and possess two integuments. The megaspore mother-cell is hypodermal and forms a T-shaped row of megaspores, the basal one of which develops into a normal eight-nucleate embryo-sac, which is covered only by the nucellar epidermis, except for the two- or three-layered nucellar cap.

Endosperm and Antipodal Cells.—In *I. alba* and *I. minuta* the development of the endosperm is nuclear and is similar to that of *I. aquatica*. The antipodal cells persist for some time after the fertilisation. In *I. alba* they degenerate when the embryo has reached the quadrant to octant stage and before cell-walls are laid down among the free endosperm nuclei. In *I. minuta* they grow larger than in *I. aquatica* and their nuclei possess large chromocentres and resemble those of glandular cells. Sometimes one of the nuclei divides. In some ovules they begin to degenerate when there are sixteen endosperm nuclei present, but in other cases they persist until cytokinesis takes place in the endosperm. After their degeneration a number of the adjacent endosperm cells becomes filled with a densely granular cytoplasm. Greyish droplets of some substance are visible opposite the antipodals in the base of the endosperm cavity.

In *I. Schlechteri* helobial endosperm formation takes place. The primary endosperm nucleus which lies near the antipodals, divides with a longitudinal spindle, thus forming two nuclei situated one above the other. The lower nucleus, lying next to the antipodal cells, is cut off from the upper one by a cell-wall or membrane, and in this way a basal endosperm cell is formed. The upper nucleus forms the endosperm tissue, first by repeated nuclear divisions until there are about 300 free nuclei present, arranged in a layer on the periphery of the embryo-sac, then by the simultaneous formation of cell-walls, and later by normal cell division.

In the basal endosperm cell the nucleus also divides repeatedly and forms a multinuclear chamber with dense cytoplasm and at least 16 nuclei, crowded together. Afterwards this chamber divides irregularly into a number of cells, a few of which have a single nucleus and others more than one. No granular food-reserves are stored in these cells, and later they become flattened and subsequently degenerate. In the endosperm cavity some greyish droplets are visible opposite the basal cell.

The nuclear divisions in the upper and lower chambers do not occur simultaneously, the mitoses in the upper chamber or endosperm proper being more frequent.



FIGS. 26—31. Formation of endosperm in *Ianthe Schlechteri*. 26. First division of primary endosperm nucleus; 27. A cell-wall or membrane being formed after the first division of the primary endosperm nucleus; 28. Embryo-sac divided into a basal and an upper chamber, each with one nucleus; 29. Basal endosperm cell showing three out of four nuclei, upper cell with two free nuclei; 30. Basal cell with a number of nuclei; endosperm tissue in the upper chamber; 31. Older endosperm tissue; the basal cell has divided into a number of cells, some of which are degenerating; A. Antipodal cells; B. Basal endosperm cell; EN. Endosperm tissue; S. Droplets. Figs. 26—28 $\times 450$; Figs. 29—31 $\times 300$.

FIGS. 32 and 33. *Ianthe minuta*. 32. Mature embryo-sac after fertilisation; 33. Base of old embryo-sac showing free endosperm nuclei and persistent antipodal cells. A. Antipodals; D. Primary endosperm nucleus; E. Fertilised egg-cell; S. Droplets. $\times 300$.

When the basal endosperm cell has two or four nuclei, the antipodal cells degenerate, but they are still visible for some time as blackened masses. Hypertrophy of the endosperm is of rare occurrence in these three species.

Embryo.—The early stages in the development of the embryo in *I. alba* and *I. Schlechteri* are similar to those of *I. aquatica*. After the sixteen-celled stage the embryos were not studied except in the ripe seeds, where they were found to resemble those of the previously studied species.

Testa.—The structure of the testa in the three species under discussion is fundamentally similar to that of *I. aquatica*, and only slight differences occur between the species, e.g. the number and size of the cells of the outer layer and the length of the protruding outgrowths. In *I. minuta* these cells and protuberances are few in number and much larger than in *I. aquatica* and *I. alba*.

Another slight difference is found in the width of the outer integument. In *I. minuta* this consists of two layers of cells, but in *I. alba* the inner layer of this integument has been duplicated in the region of the raphe. In *I. Schlechteri* this integument is similar to that of *I. aquatica* and also is largely two-layered.

As in *I. aquatica*, the nucellus is absorbed in the ripe seed, except for the cuticle, the nucellar cap at the micropyle and some cells at the base of the endosperm.

DISCUSSION.

The development of the embryo in the species of *Ianthé* conforms to the Asterad type (Schnarf, 1929; Johansen, 1945). In this type the apical cell of the two-celled pro-embryo divides by means of a longitudinal wall, and both the apical and the basal cell contribute largely to the structure of the embryo.

The early development of the embryo is similar to that of *Anthericum ramosum* (Souèges, 1918). The latter found that in this species the cotyledon was derived from the apical cell, the hypocotyl from *m*, the hypophysis from *n*, and that *o* and *p* formed the suspensor. (The same symbols that Souèges employed are used in this investigation.) In *Ianthé* the apical cell of the pro-embryo also forms the cotyledon, and the other parts of the embryo are likewise formed from cells contributed by the basal cell. It was, however, impossible to determine the origin of the hypocotyl and the radicle, but it was evident that the suspensor in *Ianthé aquatica* is derived only from the cell *p* and that the cell *o* also contributes to the structure of the radicle.

The development of the ovule and the embryo-sac in the four species of *Ianthé* agrees with Stenar's results in *Hypoxis decumbens* and *H. villosa*, and this confirms the very close relationship between the two genera. The only difference was found in the formation of the endosperm and in the persistence of the antipodal cells. In the above-

mentioned species Stenar found the endosperm to develop according to the Helobiae type (1925; 1938, p. 281), but the present investigation shows that this occurs only in *Ianthé Schlechteri*, the other three species showing a nuclear endosperm formation. *Ianthé* is therefore another genus with two types of endosperm development. The formation of the endosperm therefore has no great systematic value, at least in the Hypoxiadeae, to show relationships with other genera. Whether it has any taxonomic importance within the genus, is impossible to say as yet, as the endosperm formation in only four out of about twenty species has been studied. These four species belong to the following subgenera (Nel, 1914b) :—

<i>I. alba</i> , <i>I. aquatica</i> , with 3 other species	..	Aquaticae
<i>I. Schlechteri</i> (the only species)	.. ..	Pectinatae
<i>I. minuta</i> (the only species)	.. ..	Minutae

The Aquaticae is the oldest group (Nel, 1914a) and the other two groups are more specialised, the Pectinatae being the most highly evolved. Only the latter shows endosperm of the helobial type.

In the three species with nuclear endosperm development the antipodal cells are large and persist for a long time after fertilisation, whereas in *I. Schlechteri* they degenerate earlier, but not before the fertilisation as Stenar found for the two species of Hypoxis. These persistent antipodal cells probably help in passing food-materials into the embryo-sac. The integuments are very deeply cut and all the materials that enter the embryo-sac have to pass through a very narrow passage opposite which these cells are situated. In *I. Schlechteri* this function of the antipodal cells is probably taken over by the basal endosperm chamber. That food materials enter the sac through the chalazal passage, is also indicated by greyish droplets visible opposite the passage in the endosperm cavity.

The antipodal cells and the basal endosperm chamber in *I. Schlechteri* do not enlarge to such an extent that they can be designated as typical chalazal haustoria, as Schlimbach (1924) found to be present in *Curculigo*.

SUMMARY.

1. The development of the ovule and seed in the four species of *Ianthé* investigated is similar, except for the formation of the endosperm.

2. The hypodermal archesporial cell functions as megaspore mother-cell and forms a T-shaped row of megaspores, the chalazal one developing into a normal eight-nucleate embryo-sac. The nucellus remains small and the mature embryo-sac is covered only by the nucellar epidermis which is absorbed before the seed is ripe.

3. The antipodal cells persist for some time after fertilisation and in one species one or two of them may divide.

4. In the three species, *I. alba*, *I. aquatica* and *I. minuta* the development of the endosperm is nuclear, but in *I. Schlechteri* according to the helobial type.

5. The development of the embryo in *I. aquatica* is explained. It conforms to the Asterad type, and the apical cell of the two-celled pro-embryo forms only the terminal cotyledon.

6. The seed-coat is formed by the two integuments, and its structure is explained.

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FURTHER NOTES ON SOUTH AFRICAN SAPOTACEAE.

By REV. J. GERSTNER, PH.D.

Chrysophyllum magalismontanum Sond.

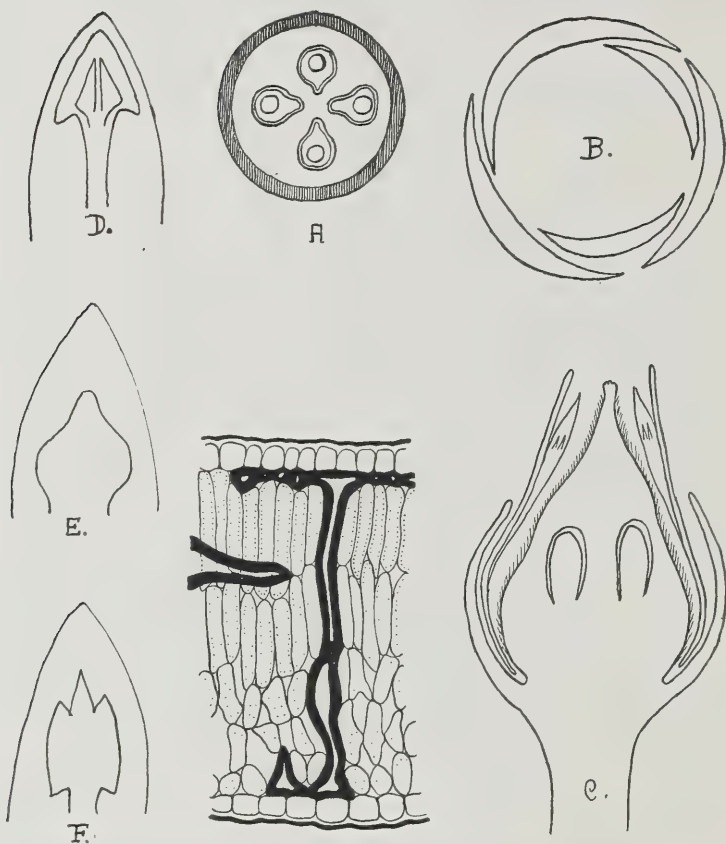
I examined flowers of this species in different habitats. In places in Natal (Magut) and the Transvaal (Hartebeestpoort Dam), where little or no frost occurs, this species develops perfect flowers, with five fertile stamens even before the first rain of the spring. But this is not the case in the Johannesburg area (Kensington) where heavy frost occurs. On the granite hills of Kensington I found shrubs of this species 3 ft. high with imperfect female flowers only, on 21st September, 1947, before the first rains arrived and after a severe drought of several months. There was no trace of male flowers anywhere. These imperfect female flowers had as a rule a four-locular ovary with single ovules. Instead of the usual five stamens in front of the corolla lobes there were only staminodes of different forms. This is *Chrysophyllum Wilmsii* Engl. Cf. Fig. A—F.

About four weeks later, on 18th October, 1947, I examined the flowers of the same shrub again. Rain had fallen since and the hill looked green and fresh. But *Chrysophyllum Wilmsii* with four-locular ovary and five staminodes was not in evidence. All the fresh flowers were perfect specimens of *Chrysophyllum magalismontanum* Sond. with well-developed stamens full of pollen, and the ovaries were five-locular. *Chrysophyllum Wilmsii* Engl. has therefore definitely to be sunk. I propose to call it in future *Chrysophyllum magalismontanum* Sond. *forma depauperata*. The influence of the cooler season and the drought is obvious in causing such a starved form. Cf. Burt Davy, Check list of flowering plants of Natal, 1911, p. 156, and Gerstner No. 6424 (Nat. Herb. Pretoria).

Manilkara Adanson.

Three species of *Manilkara* are recorded in South Africa. What I described in this Journal, April, 1946, as the section *Hexalobatae* of the genus *Mimusops* constitutes the Genus *Manilkara* Adanson. We have, therefore, at least the following species of *Manilkara* in South Africa:—

- (a) ***Manilkara concolor*** (E. Mey.) Gerstner nov. comb.
- (b) ***Manilkara moehisia*** (Baker) Gerstner nov. comb. (The necessary figures and notes to these two species can be found in this Journal, April, 1946, under *Mimusops*).



Chrysophyllum magalismontanum. A. Horizontal section through the ovary, diagrammatic; B. Horizontal section through the calyx, diagrammatic; C. Vertical section through flower; D, E, F. Different varieties of staminodes (Del. J. Gerstner); G. Transverse section of the leaf-blade of *Manilkara concolor* (Del. H. G. Schweickerdt).

- (c) ***Manilkara Macauleyae*** (Hutch. & Corb.) H. J. Lam. nov. comb. Cf. Gerstner 6061 (Nat. Herb. Pretoria), Vanetzi River, North Transvaal. A leafy specimen, very similar to *Manilkara concolor*, but hairy and with red venation.

Besides the main difference of *Manilkara* flowers being trimerous and *Mimusops* flowers tetramerous, there is also an important vegetative

feature. The leaves of *Manilkara* have sclereids (especially frequent in *Manilkara concolor*) and those of *Mimusops* none. Cf. Fig.

Labourdonnaisia discolor Sond.

During my last trips through Natal and Zululand in 1947 and 1948, I examined the flowers of all *Labourdonnaisia*s which I could find.

One good specimen in Albert Park, Durban, showed six corolla appendages which were not even bilobate, but rather tall and simple. In the Hlabisa District I found some dried flowers which had appeared before the first rains, and had six simple lobes without appendages. But one tree with fresh buds nearly open, appearing after the first rains and growing on good black alluvial soil below the sandstones, had perfect flowers with double appendages on the back of each of the six corolla lobes. Besides the rainfall, the habitat (sand, sandstone or black alluvial soil) seems to influence the form of the flowers as well.

I propose therefore to distinguish in *Labourdonnaisia* the following forms caused by weather and soil conditions :—

- (a) *Forma perfecta* with two appendages (a *Manilkara* with the staminodes transformed into fertile stamens) found on black alluvial soil, below the sandstone formation, after good rains.
- (b) *Forma pauperescens* with the two appendages reduced to one which may be simple or bilobate but with fertile stamens. It is mostly found on deep sands near the sea, e.g. Albert Park, Durban.
- (c) *Forma pauperata* with trilobate or tridentate lobes without any appendages. Found on sandstone after short rains. Emgangado, Hlabisa District, September, 1939 with staminodes only.
- (d) *Forma depauperata* with simple lobes without appendages found on sandstone before the first rains, with staminodes only.

I found on the 22nd October, 1948, in Albert Park, Durban, that as last year the tree near the gardener's house again bore flowers of *forma pauperescens* with fertile anthers (Cf. Gerstner 6820, Pretoria and Kirstenbosch). The second tree of this Park nearer to West Street, cited as having stamens and staminodes (Harry Butcher and probably Engler) I found with plenty of flowers of *formae pauperata* and *depauperata*. The sterile anthers were small, ovate, and easily fell off (Cf. Gerstner 6821, Pretoria and Kirstenbosch). It reminds me of the sunk *Chrysophyllum Wilmsii* Engl. from the point of view of the reduced and sterile anthers, i.e. staminodes. The small sterile ovate anthers fall off very easily in this case, and the filaments then resemble the staminodes of the European botanists. I think therefore that *Mimusops natalensis* (Pierre) Engl. has also to be sunk, as Engler's drawings and descriptions suggest that they

have been drawn from specimens of *Labourdonnaisia discolor* Sond., *forma pauperata* with sterile flowers, perhaps from specimens of the same tree in Albert Park. Last year this tree had only flowers which half developed and then dried up.

Labourdonnaisia discolor seems to some European botanists to trespass into the realm of different genera (Cf. H. J. Lam, *Blumea*, Vol. 4, No. 2). But as a more detailed and exact observation in the veld reveals, the same occurrence takes place as in the sunk *Chrysophyllum Wilmsii* Engl. with this difference, that here in the case of the starvation forms of *Labourdonnaisia* not only the anthers but also the forms of the corolla lobes and their appendices are more or less essentially affected. This apparently does not occur in other families and may therefore be puzzling to botanists. In my opinion only the perfect flower form should be used for taxonomy and systematics.

REVIEW.

GASTEROMYCETES OF SOUTH AFRICA. By A. M. Bottomley. Bothalia, Vol. IV, Part III, pp. 473-810, including 79 photographic plates. Government Printer, Pretoria, 1948. Price 7/6d.

We have received with much pleasure Vol. IV, Part III of "Bothalia," which contains a monograph of the Gasteromycetes of South Africa by A. M. Bottomley, and we congratulate Miss Bottomley on the completion of a very difficult task. She modestly disclaims to have produced a critical revision of this puzzling group of fungi, but she has put together all the known South African records and described each species in what we may call the traditional manner, since no new tricks such as chemical reactions to flesh and spores have yet been found to help in diagnosis, as they do in the Agarics. Keys have been provided to run down genera and species. She has indeed written a work that was badly needed and which all mycologists will be glad to possess. The general classification is that of G. H. Cunningham. Full citations and authors are given. In addition to the text there are photographs to illustrate most of the species, and that adds considerably to the practical character of a work of this kind. Indeed without these it would be difficult in many cases to determine with any conviction many of the species, which are so often without strikingly distinct diagnostic characters.

We should have liked a few diagrammatic drawings or micro-photographs to illustrate more clearly the gleba of some of the genera, the photographs in this respect giving little or no information, and, of course, coloured drawings of the brightly-coloured species would have been welcome—but in these days the cost of such plates is prohibitive. A second index based on specific epithets would also have been useful. A few slips have been made in the proof-reading. The Clathraceae have been omitted from the general key to the families and genera. In the glossary a micron is defined as 1/1000 of an inch instead of a millimetre.

Five species new to science are described: *Lycoperdon Duthiei*, *L. Oudenii*, *Calvatia incerta*, *Bovista umbrina*, and *Geastrum dissimile*. The generic epithet *Geastrum* (Persoon, 1801) replaces the more familiar *Geaster* (Fries, 1829) since the nomenclature of the Gasteromycetes starts from Persoon.

Two species can be added to the list, *Geastrum rufescens* Pers. and *Phallus imperialis* Schulzer, both observed by Miss E. L. Stephens and the writer during the ten weeks he spent at the Cape. Brief descriptions of these are added below for the convenience of those using Miss

Bottomley's work. In view of the solitary and very old record ("outside Cape Town, Thunberg") of *Calvatia gigantea* (*Lycoperdon giganteum*) it should be mentioned that specimens of this species were collected at Stellenbosch on the 29th of May, 1948.

Miss Bottomley's excellent monograph should be an incentive to further research in South Africa, which is peculiarly rich in puff-balls of all kinds and phalloids. It is printed by and may be obtained from the Government Printer, Pretoria, as a separate part of "Bothalia," at the low price of 7/6d., post free.

Geastrum rufescens Pers.

Exoperidium up to 8 cm. wide when expanded, with 6—10 acute lobes split to the middle or beyond, rigid, thick, firm, pale ochraceous above with a pink flush, fleshy layer thick, soon cracking, often peeling. *Endoperidium* 2—3 cm. wide, yellowish or pale brown, globose or ovoid, sessile or with a short rudimentary stem. *Mouth* indefinite, fibrillose or torn. *Spores* globose, about $4\ \mu$, echinulate, olivaceous brown. *Columella* globose, short, olive-brown. *Capillitium* olivaceous, simple, 6—7 μ diameter.

Habitat: Woods and pastures. Bergvliet, Retreat, Cape Peninsula, 2nd May, 1948.

Phallus imperialis Schulzer.

Peridium $2\frac{1}{2}$ —7 cm., smooth at first, ovoid, pink, with a cord-like mycelium below, splitting at the apex into two or more lobes and remaining as a persistent volva at the base of the stem. *Stem* (receptacle), 10—16 cm. high (recorded to 25 cm. in Europe), 2—3 cm. diameter, cylindrical or ventricose, white, turning a very pale buff, hollow, soft, spongy and pitted with shallow holes. *Pileus* 3—5 cm. high, white but covered with greenish-black gluten or mucus, adnate, conical, reticulate-alveolate, the ridges of the net shewing white through the gluten and with a white cup-like apex which is the hollow top of the stem; base usually oblique. At the base of the stem is a thin white membranous sheath surrounded by a soft brownish-hyaline jelly, all enclosed by the pink peridium. *Smell* strong but pleasant, of new meal or raw liquorice (*Glycyrrhiza*). *Spores* hyaline, cylindric, smooth, $2\frac{1}{2}$ — $3\frac{1}{2} \times 1\frac{1}{4}$ — $1\frac{1}{2}\ \mu$.

Habitat: Solitary or in troops on lawns or bare soil of gardens. Wynberg, C.P., 22nd May, 1948. Plumstead, C.P., 9th June, 1948.

This species is included by Miss Bottomley among the synonyms of *Phallus impudicus*, of which she says "it seems a bit doubtful if the species occurs in South Africa"; but it differs in both smell and colour.

A. A. PEARSON.

INDEX OF PLANT NAMES.

	PAGE		PAGE
Acacia Borleae Burtt Davy	24, 25	Aloe vulgaris	1
.. capensis Burch.	24	.. Wooliana Pole Evans	12
.. hirtella E. Mey	19, 21, 23	Amaryllis cinnamomea L'Her.	82
.. horrida F.C.	24	.. crispa Jacq.	82
.. inconflagrabilis Gerstner	19-27	.. orientalis L.	83
.. karroo Hayne	19-24	.. spiralis L'Her.	81
.. karroo var. Transvaalensis		.. stellaris Jacq.	81
.. Burtt Davy	21	Anthericum ramosum	167
.. natalitia E. Mey	19-24	Aphanomyces laevis de Bary 141, 149	
.. nilotica Thunb.	24	.. stellatus de Bary 142, 149	
.. seyal Delisle	24	.. spp.	148
Achlya ambisexualis	136	Apicra bicarinata	97
.. dubia Coker	139, 148, 149	Arachis hypogaea	71-73
.. imperfecta Coker	138, 148, 149	Aristea umbellata Spreng.	86
Agathaea amoena	84	Arthrocnemum africanum Moss	37
Agave virginica	98	.. capensis Moss	39
Albica canadensis (L.) Leighton	83	.. littoreum Moss	38
.. major L.	83	.. perenne (Mill) Moss	40
.. minor L.	83	.. Pillansii Moss	38
Alectorolophus	65	.. variflorum Moss	39
Alectra Thunb.	63	Aster exilis Ell.	84
.. Vogelii Benth.	63-77	.. fruticosus L.	84
Allomyces arbuscula	136		
.. sp.	147, 148, 149	Bobartia umbellata Ker.	86
Aloe americana ananafolius etc.	3, 8	Brunsvigia Comptonii Barker	29, 30
.. bulbicaulis Christian	11, 12	.. gigantea Heister	83
.. capensis arborescens ramosa	6	.. multiflora Ait.	83
.. chortolirioides Berger	12	.. orientalis (L.) Ait. ex.	
.. dichotoma	6	.. Eckl.	83
.. dominella Reynolds	12	.. radula Ait.	31
.. ferox Mill.	5	.. striata Ait.	31
.. Indiae Orientalis	8		
.. kniphofioides Bak.	9-12	Cajanus indicus	71
.. Marshallii Wood & Evans	10, 11	Carpolyza tenella Leighton	81
.. perfoliata var. ζ Linn.	4, 7	.. spiralis Salisb.	81
.. .. var. succotrina Ait.	4, 5, 8	Chironia decumbens Levyns	84
.. .. var. purpurascens		.. maritima Eckl.	84
.. Ait.	4, 5, 8	 Willd.	84
.. Perryi Bak.	3, 4, 5	Chrysophyllum magalismontanum	
.. pluridens Haw.	6	.. Sond.	171, 172
.. purpurascens Haw.	5-8	 Wilmsii Engl.	171
.. ramosa Haw.	6	Crinum tenellum L.f.	81
.. serrata	8	Crotalaria juncea	71
.. sinuata Thunb.	5, 8		
.. soccotrina	7	Dactylis glomerata	121
.. .. var. saxigena Berger	7	Dichtyuchus monosporus Leitgeb.	140, 148, 149
.. .. β purpurascens	5, 8		
.. spinosa arborescens ramosa	6	Diplopappus fruticosus Less.	84
.. succotrina β purpurascens	3	 fruticosus (L.) Levyns	84
.. .. Lam.	1-7	Disa barbata Lindl.	85
.. .. angustifolia spinosa	3, 8	.. lacera Swartz	85
.. vera Linn.	2, 3, 4, 5	 var. multifida N.E.Br.	85
.. .. Mill.	8	.. venusta Bolus	85
.. .. minor	3, 8	Dolichos donchos	71

	PAGE		PAGE
Eleocharis Lepta	84	Haworthia Jonesiae	60
Eroeda Levyns	83	" limifolia Marl.	59
" capensis (L.) Levyns ..	84	" lisbonensis	57
" hirta (Thunb.) Levyns ..	84	" longiana var. albinota	
" imbricata (Lam.) Levyns ..	84	G. G. Smith	44, 47
" intermedia (DC.) Levyns ..	84	" v. Marlothiana	59
" laevis (DC.) Levyns	84	" mirabilis Haw.	44
" Muirii (C. A. Smith) Levyns	84	" musculina G. G. Smith	49, 50
Euphrasia	65	" notabilis v. P.	56
Evanthe	78	" paradoxa v. P.	55
Exohebe parviflora (Jacq.) Foster	85	" Parksiana v. P.	56
		" Reinwardtii Haw. ..	60, 61
Felicia amoena (Sch. Bip.) Levyns	84	" " var. bellula	54
" Pappei (Harv.) Bolus & W.-		" " var. dimi-	
Dod.	84	nuta G.	
		G. Smith	
Gasteria acinacifolia	102		52, 53
" brevifolia	102	" " var. olivacea	
" laetepunctata	102	G. G. Smith	58
" maculata	97	" " var. tenuis	
" nigricans crassifolia	97, 102	G. G. Smith	
" " var. fasciata	102		49, 50
" nitida	102	" retusa	61
" obtusifolia	102	" v. Schuldteana	59
" parviflora	102	" tessellata	57
" planifolia	102	" Venterii	55, 56
" pulchra	102	" viscosa var. quaggaensis	
" sulcata	98, 102	G. G. Smith	46, 47
" verrucosa	102	Helianthus annuus	71
Gastrum rufescens Pers.	176	Herschelia lacera (Swartz) Lewis ..	85
Gladiolus moticolus Lewis	85	" venusta Kranzl.	85
" tabularis Eckl.	85	Hessea bachmanniana Schinz	82
Glycine hispida	71	" brachyscypha Bak.	82
		" burchelliana B. & H. ..	82
Haemanthus spiralis Ait.	81	" cinnamomea (L'Her.) ..	82
Haworthia atro-fusca G. G. Smith	41	" crispa Salisb.	81, 82
" angustifolia var. pauci-		" dregeana Kunth.	82
folia G. G.		" filifolia B. & H.	83
Smith	48, 50	" gemma B. & H.	82
" " var. albanen-		" Karooica Barker	82
sis	49	" Leipoldtii L. Bolus	82
" " var. grandis	49	" Schlechteri O.K.	83
" attenuata Haw.	56	" spiralis Berg.	81
" Carrissoi	57, 58	" stellaris Hert.	81
" Cassytha	58	" unguiculata Barker	82
" Chalwinii	58	" Zeyheri Bak.	82
" coarctata v. Haworthii ..	58	Homeria bobartioides L. Bolus ..	85
" cymbiformis	59	" miniata	87
" " fasciata v. varia-		" umbellata (Thunb.) Lewis	86
bilis v. P.	58	Homoglossum Merianellum L.	34
" Eilyae	60	Hypoxis decumbens	162
" glauca	57	" villosa	167
" Greenii	58		
" " forma pseudo-		Ianthe alba (L.f.) Salisb. ..	165, 168
coarctata Res.	58	" aquatica (L.f.) Williams	
" " var. silvicula G.			159, 160, 161
G. Smith	58		
" heidbergensis G. G.			
Smith	42		
" Jacobseniana	60		

	PAGE		PAGE
<i>Ianthe minuta</i> (L.f.) Williams	165, 166, 168	<i>Periphanes brachyscypha</i> (Bak.)	
„ <i>Schlechteri</i> (Bol.) Williams	165, 166, 168	„ <i>Leighton</i>	82
<i>Imhofia Burchelliana</i> Herb. ..	82	„ <i>cinnamomea</i> (L'Her.)	
„ <i>filifolia</i> Herb.	83	„ <i>Leighton</i>	82
„ <i>gemmata</i> Herb.	82	„ <i>crispa</i> Salisb.	82
<i>Iris Pavonia</i> Curt.	89	„ <i>dregeana</i> (Bak.) Leigh-	
„ <i>tricuspidata</i> Linn.	86	„ <i>ton</i>	82
„ <i>tricuspis</i> Jacq.	86	„ <i>gemmata</i> (Ker.) Leigh-	
„ „ Thunb.	86	„ <i>ton</i>	82
<i>Labourdonnaisia discolor</i> Sond. ..	173	„ <i>karooica</i> (Barker) Leigh-	
<i>Leucojum Strumosum</i> Ait.	83	„ <i>ton</i>	82
<i>Lippia ovata</i> L.	85	„ <i>Leipoldtii</i> (L. Bolus)	
<i>Manilkara concolor</i> (E. Mey) Gerst-		„ <i>Leighton</i>	82
„ <i>ner</i>	171	„ <i>spiralis</i> (Bak.) Leighton	
„ <i>Macauleyae</i> H. J. Lam. ..	172	„ <i>stellaris</i> Salisb.	81
„ <i>mochisia</i> (Baker) Gerst-		„ <i>strumosa</i> (Ait.) Leighton	83
„ <i>ner</i>	171	„ <i>unguiculata</i> (Barker)	
<i>Melasma</i> Berg.	63	„ <i>Leighton</i>	82
<i>Microdon capitatus</i> (Berg.) Levyns	85	„ <i>Zeyheri</i> (Bak.) Leigh-	
„ <i>ovatus</i> Choisy	85	„ <i>ton</i>	82
<i>Mimuspops natalensis</i> Engl. ..	173	<i>Phalaenopsis</i>	78
<i>Monadenia ecalcarata</i> Lewis	31, 32, 33	<i>Phallus imperialis</i> Schulzer ..	176
„ <i>conferta</i>	31, 33	<i>Phaseolus aureus</i>	71
„ <i>micrantha</i>	33	<i>Pisum sativum</i>	71
<i>Moraea aristata</i> Asch. & Graeb. ..	86	<i>Pythium dissotocum</i> Dreschler	
„ <i>candida</i> Baker	89	„ 143, 148, 149, 157	
„ <i>confusa</i> Lewis	89	„ <i>perniciusum</i> Serbinow	
„ <i>edulis</i> Ker.	85	„ 144, 149, 157	
„ <i>edulis</i> Ker. var. <i>longifolia</i> ..	88	„ <i>polytylum</i> Dreschler	
„ <i>fasciculata</i> Soland.	86	„ 145, 148, 149, 157	
„ <i>glaucoptis</i> Drap.	86	„ <i>splendens</i>	153
„ <i>polyanthos</i> Thunb.	87	„ <i>sp.</i>	148, 149, 157
„ <i>tricuspidata</i> Lewis	89	„ <i>ultimum</i> Trow.	
„ <i>tricuspis</i> Ker.	86	„ 146, 148, 149, 157	
„ <i>unbellata</i> Thunb.	85	<i>Romulea longituba</i> L. Bolus ..	89
„ <i>villosa</i> Ker.	87	<i>Salicornia fruticosa</i>	38
<i>Olpidiopsis ricciae</i>	136	„ „ var. <i>paarden-</i>	
<i>Ornithogalum canadense</i> L. ..	83	„ <i>eilandica</i>	40
<i>Orobanche speciosa</i>	65, 69, 77	„ „ var. <i>radicans</i> ..	40
<i>Oxalis arthropphylla</i> Turcz. ..	13	„ <i>herbacea</i>	37
„ <i>dentata</i> Jacq.	18	„ <i>lignosa</i> Woods	40
„ <i>Fergusoniae</i> Salter	16	„ <i>Meyeriana</i> Moss. ..	36
„ <i>flava</i> L.	18	„ <i>natalensis</i> Bunge ..	38
„ <i>incarnata</i> L.	18	„ <i>perennis</i> Mill.	40
„ <i>laburnifolia</i> Jacq. 13, 14, 15, 18		„ „ var. <i>radicans</i> ..	40
„ „ var. <i>latifo-</i>		„ <i>radicans</i> Sm.	40
„ <i>lia</i> 14, 16		<i>Saprolegnia delicata</i> Coker	
„ <i>purpurea</i> L.	13, 14, 15, 18	„ 137, 148, 149, 157	
„ <i>sanguinea</i> Jacq. 13, 14, 15, 18		„ <i>ferax</i>	136
		„ <i>parasitica</i>	153
		<i>Scirpus delicatulus</i> Levyns ..	84
		„ <i>Leptus</i> (C.B.Cl.) Levyns ..	84
		<i>Selago capitata</i> Berg.	85
		„ <i>cylindrica</i> Levyns ..	34, 35
		„ <i>scabrida</i> Thunb. ..	34, 36
		<i>Senecio discifolius</i>	122
		„ <i>isatideus</i> D.C. 107, 121, 122	
		<i>Sphenostylis angustifolia</i> ..	70, 71, 72
		<i>Stizolobium duringianum</i> ..	71

	PAGE		PAGE
<i>Striga lutea</i> Lour.	63-77	„ <i>Bellendeni</i> Sweet	87
<i>Stumaria crispa</i> Gawl.	82	„ <i>fugax</i> De la R.	88
„ <i>filifolia</i> Edwards	83	„ <i>glaucoptis</i> DC.	86
„ <i>gemmata</i> Ker.	82	„ <i>tricuspidis</i> Spreng.	86
„ <i>spiralis</i> Ait.	81	„ <i>villosa</i> Spreng.	87
„ <i>stellaris</i> Gawl.	81		
„ <i>strumosa</i> Salisb.	83	<i>Watsonia tabularis</i> Mathews & L. Bolus	34
<i>Vicia faba</i>	71	„ <i>var. concolor</i> Lewis	34
<i>Vigna ervilla</i>	71	<i>Welwitschia mirabilis</i>	105
„ <i>sativa</i>	71		
„ <i>sinensis</i>	71		
<i>Vieusseuxia aristata</i> Houtt.	86	<i>Yucca flaccida</i>	97
„ „ <i>De la R.</i>	88	„ <i>filamentosa</i>	98



